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SCIENTIFIC ASPECTS OF SILK PRODUCTION

LIKE many other Indian Industries, silk production, in the past, has had to pass through many vicissitudes and misfortunes; these periodic crises have been analysed neither with sufficient scientific precision nor with a full appreciation of the complex factors which influence the biological production of silk. The approach to the problem hitherto has been largely on the economic and organisational fronts and all the serious and conscientious attempts in this direction have not apparently helped this important industry to stabilise itself.

The finding that the silk fibre offers the best and the safest material for the manufacture of parachute fabrics, was responsible for rocketting the prosperity of the industry during the war. As was expected, with the return of peace, and with the phenomenally rapid rehabilitation and rise of the Japanese industry, the Indian silk is, at the moment, threatened once again with a crisis.

Our contributions to the scientific studies of the silkworm and of its fibre, have not been comparable either in quality or in quantity to those made by others in this field. Our researches in this direction would be appraised as comparatively inconsequential, mediocre and third rate. The reasons are not far to seek. In spite of the great and abiding interest which our National Government have recently been evincing, the general conditions for scientific work in the Country still remain uncertain and discouraging; they cannot attract first-rate men to take up scientific research as a career. Plans and proposals for starting a Central Institute for Silk Research, we are told, were made three years ago; nothing concrete, however, has so far emerged. The Government has been slow in taking decisions in this matter.

To-day, the investigator who aspires to

elucidate the fascinating problems of silk production—biological and biochemical—is in an exceptionally advantageous and a far happier position. If he is properly equipped, he can command a variety of experimental techniques and methods which have been developed in recent years. In this connection we must refer to the spectacular work of Zamecnik and his colleagues (*Science*, 1949, 109, 624) who, working in the Chemical and Biological Laboratories of the Harvard University, have accomplished the biological synthesis of radioactive silk. They have tested the ability of the giant silkworm *Platysamia cecropia*, to incorporate radioactive glycine and alanine into the silk it synthesises. The radio activity was shown to be present in the α-carboxyl group of some amino acid associated with the silk fibre.

Silk is a protein, biologically elaborated by the silkworm and broadly comparable to the casein elaborated by the mammary glands of the cow, to the albumin of the egg laid by the hen and to the wool grown by the sheep.

Thanks to the brilliant and sustained researches of the European, the American and the Australian investigators, the efficiency of the three biological agencies—the cow, the hen, and the sheep—as converters of their respective feed proteins into their characteristic protein secretions—the casein of the milk, the albumin of the egg, and keratin of the wool fibre—have been worked out. The cow has been found to possess a conversion efficiency of about 80 per cent.; the hen comes next with an efficiency of only 50 per cent. In the case of the sheep, Australian workers have found that a daily dose of a gram of cystine increases the yield of wool by 30 per cent.

The biological efficiency of the silkworm as a converter of feed protein into silk protein is a problem which awaits solution. There are several other problems of similar magnitude and importance facing us in the field of silk production.

The All-India Silk Board, which, we understand, has been constituted, will, we hope, take up this question and lay down a progressive policy of vigorous and sustained research which must be recognised as the only infallible and rational means of placing the silk industry on a sound and stable foundation.

THE ATOMIC CLOCK

FOR many years, at the United States Naval Observatory and other national observatories where time is recorded and dispensed, quartz-crystal-controlled clocks have been used to keep time as accurately as does the earth itself—to about 1/1,000 of a second per day. Nevertheless, quartz-crystal clocks are subject to vagaries that have indicated the need for even more accurate means of control. This has now been found in what is known as the "atomic clock," developed at the National Bureau of Standards by Dr. Harold Lyons and members of the staff of the Bureau's microwave research laboratory.

The frequency of an absorption line produced in the microwave region of the spectrum by ammonia gas under a pressure of 10 or 15 microns is now used as the "governor" on apparatusc apable of time constancy of one part in 10 million, with a theoretical potential accuracy of one part in a billion or more. If the microwave signal output of a quartz-controlled frequency generator differs in frequency from that of the ammonia absorption line, the control circuits generate an error signal which brings the microwave signal back to the frequency of the spectrum line.

In addition to its obvious astronomical applications, such as furnishing an invariant check of the earth's rotation, the atomic clock will prove invaluable in many fields. It will provide room for more stations in the radio broadcast spectrum, as station transmitter frequencies can be maintained to very close tolerances. It will aid all radar operations and navigation systems that depend on radio, and will assist in basic research in microwave spectroscopy and molecular structure. (By courtesy to *Sky and Telescope*, 1949, VIII, P. 223.)

THE EFFECT OF CARBON MONOXIDE ON THE RESPIRATION OF ARTIFICIALLY BIVOLTINIZED SILKWORM EGGS*

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IN earlier publications of this series (Wolsky, [1, 2, 3]) the theory has been advanced (based on concepts of Rumström and other concerning sea-urchin eggs, *e.g.*, [4, 5]) that the increase in the intensity of respiration that occurs in silkworm eggs at fertilization is due to a change in the submicroscopic structure of the cytoplasm of these eggs (see also Wolsky[6]). This is supposed to remove some barriers between respiratory enzymes and their substrates and to make the enzymes (the amount of which does not change) more "saturated", *i.e.*, heavier engaged in their catalytic activity than before fertilization. This would explain the fact that before fertilization the respiration cannot be blocked with mixtures of oxygen and carbon monoxide (one of the specific poisons of the iron containing respiratory enzyme known as Warburg's "Atmungs-ferment" or cytochrome-oxydase) whereas it becomes susceptible to this poison at fertilization when the rate of respiration is almost doubled. The explanation which the theory offers is the following (see also Fig. 1):

(1) Before fertilization the cytochrome oxidase is in surplus and only a fraction of it is actively engaged in the catalysis of respiration. Therefore the carbon monoxide (which competes with oxygen for the enzyme so that they "partition" it among themselves according to Warburg's formula) combines with surplus only leaving enough of the enzyme free to combine with oxygen and to keep up the respiration at the level which is normal in this stage.

(2) After fertilization a far greater portion of the cytochrome-oxydase is "on duty", i.e., becomes engaged in the catalysis of respiration and the reserve is greatly reduced. Therefore a similar treatment with oxygen-carbon monoxide mixtures will affect not only the reserve of the enzyme but also that part which is needed for the upkeep of the respiration. Consequently the rate of respiration will be reduced.

It is clear that this explanation supposes a close correlation between the rate of respiration and its susceptibility to carbon monoxide: the higher the rate of respiration the stronger should be the inhibiting effect of a certain carbon monoxide - oxygen mixture. This in turn indicates that an argument could be furnished in favour of the theory if the rate of respiration could be raised artificially in silkworm eggs and the effect of a certain carbon monoxide-oxygen mixture upon this increased respiration would prove to be stronger than upon the normal rate. The possibility of carrying out this experiment was given when it was found that the treatment, by which eggs of univoltin races† are artificially bivoltinized, enhances the respiration of these eggs (see Wolsky.) The treatment consists in bathing the eggs in 50 per cent. hydrochloric acid for 10

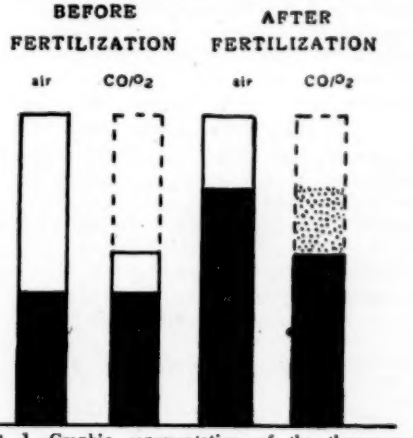

FIG. 1. Graphic representation of the theory put forward to explain the different effect of carbon monoxide on the respiration of silkworm eggs before and after fertilization. The columns represent the total amount of the cytochrome oxidase. The dark zone of the columns represents the portion which is actively engaged in the catalysis of respiration, the light zone represents the reserve. The part of the columns drawn with full lines (and jet black in the dark zone) denotes the portion of the cytochrome oxidase available for respiraion, *i.e. not* poisoned by carbon monoxide; the part drawn with broken line (and dotted in the dark zone) represents the portion poisoned by carbon monoxide. (The total amount of cytochrome oxidase given in the graph is fictitious; probably it is greater in comparison to the part engaged in respiration, *i.e.* the light zone of the columns should be higher in comparison to the dark one.

* Contributions to the knowledge of the respiratory mechanism of silkworm eggs. IV.

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† Races which have one generation a year.

minutes within 24 hours after they have been laid and afterwards washing them in running water for at least 30 minutes. Eggs of the univoltin race "Moretaina" treated in this way have been—after checking their oxygen uptake in air¶—put in mixtures on carbon monoxide and oxygen and their oxygen uptake measured in these mixtures. At the same time eggs of the same raft which were not treated with hydrochloric acid were also used for similar experiments to compare the effect of the same carbon monoxide-oxygen mixtures on bivoltinized and not-bivoltinized eggs. Carbon monoxide and oxygen were mixed in the ratio of 9 : 1 and 8 : 2 respectively. The measurements were made with the method described before (Wolsky[7]). Typical results of the experiments are given in Table I.

TABLE I

Oxygen uptake of not bivoltinized (control) and bivoltinized silkworm eggs in cu. mm. per hour per 500 eggs, in air and in carbon monoxide-oxygen mixtures, at 26° C. The column n gives the rate of oxygen consumption in the carbon monoxide-oxygen mixtures expressed in percentage of the consumption in air

Number of Experiment	Not bivoltinized			Bivoltinized			CO/O_2 ratio
	Air	CO/O_2	n	Air	CO/O_2	n	
20/7 A	20·0	15·4	77	29·0	19·0	66	
20/7 B	15·0	13·0	87	22·4	16·6	73	9 : 1
10/8 A	22·4	16·0	71	36·0	24·4	62	
10/8 B	20·4	14·0	72	34·2	21·4	63	
21/7 A	20·0	21·0	100	27·0	22·2	82	
21/7 B	20·0	20·0	100	26·0	20·4	75	8 : 2
9/8 A	24·0	24·2	100	32·2	30·2	94	

These results show that the artificial bivoltinization with hydrochloric acid has increased the respiration in all cases quite considerably which confirms the earlier results. Indeed the increase is in some cases even greater than reported before. Together with this increase the susceptibility of the respiration to carbon monoxide also increases. Using a mixture of 90% CO & 10% O_2 the so-called residual respiration (n) expressed in percentage of the normal is about 75 per cent. for not-bivoltinized eggs but only about 66 per cent. for bivoltinized eggs. Using a mixture of 80% CO & 20% O_2 the difference becomes still more striking as this mixture does not at all affect the oxygen uptake of not-bivoltinized eggs (n=100) but depresses the uptake of bivoltinized eggs (n=75 to 94). This is very nearly the same difference which we have between fertilized and unfertilized eggs. These figures definitely prove that an experimentally increased respiration becomes automatically more susceptible to CO than normal respiration and this speaks greatly in favour of the theory put forward to account for the difference in carbon monoxide-susceptibility before and after fertilization.

There is however one more point which needs some explanation. According to the abovementioned theory the limiting factor of the oxygen-consumption in carbon monoxide mixtures should be the amount of cytochrome-oxydase which is not poisoned by CO. As this must be the same both in bivoltinized and not-bivoltinized eggs (the treatment with hydrochloric acid could not have changed the amount of cytochrome oxidase in bivoltinized eggs), we should expect the rate of oxygen consumption to be lowered to exactly the same level in both kinds of eggs. But in fact this is never the case. The bivoltinized eggs although relatively stronger affected by carbon monoxide than the not-bivoltinized ones (as expressed in the lower values of n), nevertheless consume more oxygen in the CO-poisoned condition than the not-bivoltinized controls in the same condition (as the comparison of the absolute figures show). For example in Expt. 20/7B the oxygen uptake (in *cu.mm* per hour for 500 eggs) of not-bivoltinized eggs is lowered by carbon monoxide from 15·0 to 13·0 (n=87). In the case of the bivoltinized eggs the oxygen consumption should have been depressed by the same treatment to the same level, *i.e.*, from 22·4 to 13·0. But instead it is lowered only to 16·6 which figure is even higher than the oxygen uptake of not bivoltinized eggs in air, although it still means a relatively stronger depression of oxygen uptake than observed in not-bivoltinized eggs (n=73).

The deviation of the data from the theoretical expectation can have two possible explanations:

(1) In the bivoltinized eggs a certain degree of cytolysis may have set in. This is quite possible in view of the drastic treatment. According to earlier results (Wolsky[2]), cytolysis in slikworm eggs is connected with an increase of oxygen uptake, but

¶ Earlier experiments have shown that the oxygen uptake in a nitrogen-oxygen mixture of 9: 1 is the same as in air (*cf.* Wolsky[1]).

this increase is *not* susceptible to carbon monoxide (autoxydation of necrotic substances?). Thus it is possible that a cytolytic effect of the bivoltinizing treatment is responsible for the increased amount of carbon monoxide resistance respiration.

(2) It is possible that the same factor which is supposed to be responsible for the increase of the respiration catalysed by cytochrome-oxidase (*i.e.*, change in the submicroscopic structure of the egg-cytoplasm) may have also increased some respiratory processes which are catalysed *not* by cytochrome-oxidase but by some carbon monoxide-resistant respiratory enzymes, *e.g.*, the yellow enzyme of Warburg. This explanation is in fact an additional argument in favour of our theory as it supposes that the changes in respiration are due to non-specific causes which affect more than one single enzyme system. Such an unspecific factor would be in the first line a change in the sub-microscopic structure of the egg-cytoplasm.

SUMMARY

Artificially enhanced respiration of freshly laid fertilized silkworm eggs (treated with hydrochloric acid for bivoltinization) is more susceptible to carbon monoxide than the normal respiration. The significance of this phenomenon and the details of the results are discussed.

1. Wolsky, A., "Beiträge zur Kenntnis des. Atmungsmechanismus der Seidenspinnereier. I. Vergleich der Atmung verschiedener Entwicklungsstadien, mit besonderer Berucksichtigung der Kohlenmonoxydwirkung". *Rivista di Biologia*, 1941, **31**, 209. 2. —, "Beitrage.. etc. II. Uber den Sauerstoffverbrauch geschädigter unbefruchteter Eier," *Magyar Biol. Kut. Munk.* (Publications of the Hungarian Biological Research Institute), 1939, **11**, 375. 3. —, "Beiträge.. etc. III. Die Wirkung der Behandlung mit Selzsäure auf die Atmung." *Magyar Biol. Kut. Munk* (Publications of the Hungarian Biological Research Institute), 1942, **14**, 445. 4. Runnström, J., "Atmungsmechanismus und Entwicklungserregung bei dem Seeigelkeim," *Protoplasma* (Berlin), 1930, **10**, 106. 5. Brock, N., Druckrey, H., and Herken, H, "Der Stoffwechsel des geschädigten Gewebes' III. (Zugleich Beitrag zur Frage der Entwicklungserregung am Seeigelei.)" Nauyn-Schmiedebergs Archiv, 1938, **188**, 451. 6. Wolsky, A., "The physiology of development in Insects,'. *Proc. Nat. Inst. Sci. India*, 1949, **15**, 67. 7. —, "The effect of carbon monoxide on the oxygen consumption of *Drosophila melanogaster* pupæ." *Journ. Exper. Biology*, 1938, **15**, 225.

SUGARCANE (*SACCHARUM OFFICINARUM*) TOP SILAGE AS FEED FOR CATTLE

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THE problem of adequate supply of nutritious fodder for livestock in India durthe dry periods of the year is very baffling. After the monsoon, the cattle have to depend, for greater part of the year, for roughage supply, principally on coarse and bulky fodders like straws which are nutritionally deficient. One of the solutions of the problem seems to be in devising methods for the conservation of surplus green fodder in times of abundance, especially during monsoon months. Hay making and ensilage, if widely undertaken, may solve the problem to a great extent by providing alternative fodder of satisfactory nutritive value.

In previous articles (Kehar and Sahai, 1949; Paul and Rangaswamy, 1947) observations on the nutritive value of sugarcane tops have been reported. As already stated the estimated yield of sugarcane tops in India roughly works out to be 16 million tons annually. At present most of it goes to waste. As this huge production of cane tops is available only during the cane crushing season extending over three to four months, it is not possible to utilise the entire produce as such for feeding cattle. The additional quantity of cane tops after meeting the requirements of the livestock in those parts will be available for conservation by a suitable method. Hence measures must be adopted to conserve the surplus material, to be utilised during periods of scarcity. The observations reported in this article relate to the conservation of sugarcane tops by ensilage and the nutritive value of the ensiled product.

Green sugarcane tops chaffed into 5" to 6" bits were filled, in pits of 8' × 5' × 4'

dimensions layer by layer. After each addition of ten maunds of green material, eight to ten adult persons trampled on the mass thoroughly for about half an hour to exclude air as completely as possible. When the green material reached a foot above the ground level, the top was covered with 6" layer of dried Bharra (*Saccharum munj*) or any other coarse hay. The pits were finally covered with earth and plastered with a mixture of dung and clay. The pits were attended to occasionally and any visible crevices due to shrinkage of the material were replastered.

After a period of four months one of the pits was opened and a representative sample was taken out. The silage was found to be of a yellowish green colour with a pleasant fruity smell.

The average chemical composition of the silage along with that of the original crop is given in Table 1.

TABLE I

Chemical composition of green sugarcane tops and the silage made therefrom

	Fresh Crop	Silage
Dry matter (Percentage of fresh material)	33·86	38·25
	Percentage on dry matter basis	
Ether extract ..	1·33	2·07
Crude fibre ..	29·46	37·51
Crude protein ..	6·41	7·34
Total ash ..	8·16	9·47
Nitrogen-free extractives ..	54·64	43·61
True protein ..	4·77	4·31
Ratio $\frac{\text{true protein}}{\text{crude protein}}$ ..	0·74	0·59
Calcium (CaO) ..	0·59	0·71
Phosphorus (P_2O_5) ..	0·45	0·52
pH ..		4·67
	(Stated as c.c.	N/10 per 100 gm. of fresh silage)
Total acidity ..		231·000
Amino acids ..		49·45
Volatile acids ..		81·53
Residual acidity ..		100·02
Volatile bases ..		38·05

It will be observed that the silage showed an increased percentage content of crude protein with a diminished true protein content, evidence of the breakdown of protein during the ensiling process. The chief loss would appear to have fallen on the nitrogen-free extractives, whereas fibre content was increased appreciably. Ether extract and ash content have also shown slight increase.

To determine the nutritive value of the silage, feeding experiments were carried out, using two species of animals, namely, kumauni bullocks and buffaloes. Three animals from each species were selected and put on a daily ration consisting of silage feed *ad libitum*, supplemented by rape cake at the rate of 1 lb. per animal. Besides, each animal was given 1 oz. of common salt daily. The silage was highly relished by the animals and was quite palatable. During the feeding period lasting for twenty-five days, animals kept up a healthy appearance and gained on an average 14·7 lbs. in case of kumauni bullock group and 4 lbs. in case of buffalo group.

After a pre-experimental feeding period of 15 days, a metabolism trial was carried out on animals of both the groups. Digestibility coefficients on an average were found to be crude protein 51·24, ether extract 31·81, crude fibre 61·78, and nitrogen-free extract 38·31, for the kumauni bullock group; and crude protein 49·59, ether extract 38·25, crude fibre 63·92 and nitrogen-free extract 44·01 for the buffalo group. The nutrients in lbs. per 100lbs. of silage(dry basis) were found to be:—digestible crude protein,3·76, total digestible nutrients, 45·115, and starch equivalent, 22·909 for the kumauni bullock group; and digestible crude protein, 3·639, total digestible nutrients, 48·633, and starch equivalent, 26·383 for the buffalo group. Table II gives a comparison of the nutrients per 100 lbs. of sugarcane top silage (dry basis) with some other common silages.

TABLE II

Nutrients in lbs. per 100 lbs. of dry matter

Name of feeds	Digestible crude protein	Total digestible nutrients	Starch equivalent
Sugarcane top silage (Kumauni bullocks)	3·76	45·12	22·91
Sugarcane top silage (buffaloes)	3·64	48·63	26·38
Jowar (*Sorgum vulgare* Pers.) silage	2·35	51·13	29·10
Maize (*Zea Mays*) silage	3·41	61·43	46·80
Spear grass (*Stipa*) silage	1·74	50·22	31·00

From the above table it will be observed that, as regards digestible crude protein, the figure for cane top silage is the highest but

as regards total digestible nutrients and starch equivalent the figures for sugarcane top silage are the lowest in the list.

Balance study for nitrogen, calcium and phosphorus was also made, the results being shown in Table III.

TABLE III

Nitrogen, calcium and phosphorus balances (in gm. per day)

	Kumauni bullock group (average of three animals)	Buffalo group (average of three animals)
Nitrogen (N) ..	+6·48	+13·02
Calcium (CaO) ..	+0·50	+ 4·88
Phosphorus (P_2O_5)	+1·87	+ 3·94

As is seen from the table, the balance for nitrogen is highly positive in both the groups. Calcium and phosphorus balances are also shown to be positive on an average.

It will be observed from the above data that ensilage of sugarcane tops will yield a fodder of high nutritive value and if recourse is taken to this method of conservation the entire surplus produce of sugarcane tops will be utilised and made available for scarcity periods, when there is a great dearth of nutritious and succulent fodder.

1. Kehar, N. D., and Sahai, B., *Science and Culture* (in press), 1949. 2. Paul, T. M., and Rangaswamy, M. C., *Ind. J. Vet. Sci. and Anim. Husb.*, 1947, 17, 48.

THIRD SYMPOSIUM ON APPLIED MATHEMATICS—ELASTICITY

THE American Mathematical Society now holds annual Symposiums on selected subjects in Applied Mathematics. The subject of the first symposium, held in August 1947, was Nonlinear Problems in Mechanics of Continua. In 1948 the subject of the second symposium was Electromagnetic Theory. Both these symposiums are being published in book form.

The third annual symposium was held at the University of Michigan, Ann Arbor, Michigan, from the 14th of June to the 16th of June, 1949. The subject of the symposium was Elasticity. The Applied Mechanics division of the American Society of Mechanical Engineers was a co-sponsor of the symposium. The proceedings of this symposium are to be published in book form by McGraw-Hill.

This symposium was very well attended. On the second day about 300 mathematicians and engineers from all parts of the United States were present. There were seventeen invited papers and addresses. The Chief contributors included Sir Richard Southwell, Professor E. Reissner, Professor I. S. Sokolnikoff, Professor W. Prager, Professor D. L. Holl and Professor B. R. Seth. In the Applied Mechanics division Professor S. Woinowsky-Krieger, Mr. H. Poritsky, Professor D. C. Drucker and Professor L. H. Donnell were amongst the contributors.

Sir Richard Southwell showed how his relaxation method could be used for the elasto-plastic torsion problem. Professor E. Reissner, Professor F. B. Hildebrand and Professor K. O. Friedrichs dealt with finite deflection theory of plates and shells. Professor I. S. Sokolnikoff gave an account of methods used to solve problems in anisotropic elasticity. He showed how the perturbation method could be used to get approximate results. Professor B. R. Seth pointed out that the method implied that the anisotropic elastic constants could be obtained from the isotropic ones by adding small terms, which was not always possible. Professor D. L. Holl discussed the bending of anisotropic plates under dynamic loads.

Professor W. Prager, Professor D. C. Drucker, Professor U. Coburn, and Mr. P. G. Hodge dealt with plastic problems. Professor B. R. Seth of Hindu College, Delhi, and at present Visiting Professor of Applied Mathematics at Iowa State College, discussed some recent applications of the theory of finite elastic deformations. He criticized some papers of P. M. Riz, U. Zvolinsky R. Kappus and R. S. Rivlin. His suggestion that in the non-linear elastic domain the elastic constants should be reduced was very well borne out by papers of E. A. Davis, A. Eyering and G. Halsey, an account of which was given by C. J. Thorne. It was suggested to Professor L. H. Donnell that if these reduced values of the constants were used the wide disagreement between theory and his experimental results on buckling of thin cylinders under axial compression would become much less. Professor B. R. Seth also pointed out to Professor G. E. Hay that, in his problem of the elliptic plate under concentrated load, the use of certain relations involving stress in orthogonal curvilinear co-ordinates would enable him to obtain the solution in a closed form.

SOME EXAMPLES OF QUARTZ-GRAIN ORIENTATION IN TECTONITES AND NON-TECTONITES

SAURINDRANATH SEN

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DIAGRAMS of quartz and biotite fabric of a porphyritic granite (Manbhum), prepared in this laboratory were the first of its kind in India (Sen, 1947, 1948). The petrotectonic interpretation of quartz axes fabric in tectonites and non-tectonites that have since been studied in this laboratory are presented in this paper. It discusses the quartz fabric of the wall rocks of the porphyritic granite in Manbhum (Sen, 1947, 1948, 1949), of sandstones, quartzites and arenaceous and argillaceous metamorphites of Darjeeling (Ray and Sen, 1948, 1949) and some quartzites from Chaibassa (Saha, 1949). The direct responsibility for both the fabric work and the interpretation, in case of the Darjeeling rocks, lies with the present author. The fabric of the Chaibassa quartzites was also studied under the guidance of the author and some of the interpretations were due to him.

Manbhum.—The fabric of 150 quartz axes of granite gneiss from Jhanpra $\left(73\frac{I}{II}, 22°\ 33'\ N;\ 86°31'\ E\right)$ forming the wall of the porphyritic granite shows a very high degree of axes concentration nearly that of a S tectonite, with little scattering in a zone intermediate between *ab* and *bc*, on the *ac* plane (Fig. 1c). The mean directions of the intersecting shear joints and the tension joints have been plotted on the *ac* fabric.

The *ac* quartz fabric of a specimen of quartzite, also occurring close to the porphyritic granite, from the north of Kotra (23°25' N; 86°27' E) shows an apparently high statistical orientation as only 50 grains were measured (Fig. 1*b*). As the specimen was not oriented in the field it cannot be compared with the first diagram (Fig. 1c): it may very well fit into the first, only the

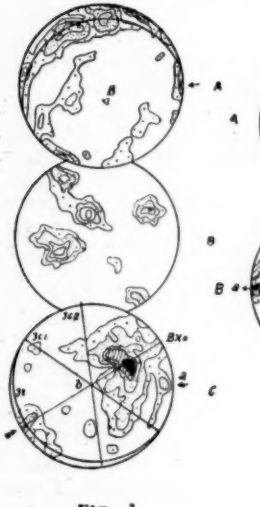

FIG. 1

Quartz Fabric (*Manbhum*)

A. 200 quartz axes of a quartzite from Ramchandrapur. B. Quartzite-forming wall, Kotra, 50 axes. C. 150 quartz axes of a granite-gneiss, Jhanpra.

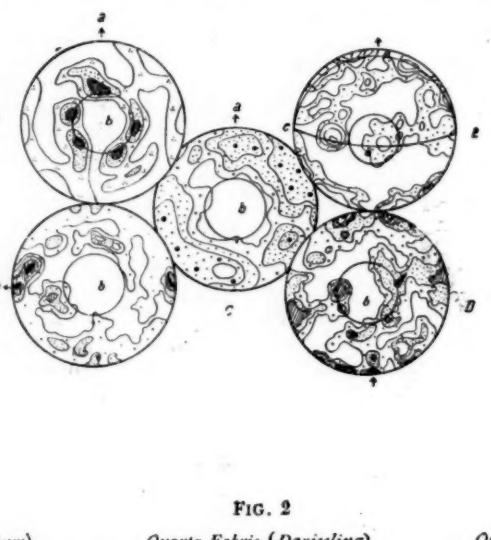

FIG. 2

Quartz Fabric (*Darjeeling*)

A. Gondwana sandstone, 150 axes. B. Gondwana sandstone from a shear zone, 200 axes. C. A specimen from Garnet zone 200 axes. D. Specimen 104 from Garnet zone 100 axes. E. 100 quartz axes from a kyanite-quartz rock, Kyanite zone.

FIG. 3

Quartz Fabric (*Chaibassa*)

A. 60 quartz axes on *ab* of a quartzitic sandstone. B. 200 quartz axes of a quartzitic sandstone (idealised).

maximum lies closer to *b* than in the previous diagram.

The fabric of 200 quartz axes in the *ac* plane, of a quartz-sillimanite schist from near Ramchandrapur peak (23°34′ N; 86°48′ E) lying at an appreciable distance form the porphyritic granite, shows a well-developed peripheral *ac* girdle with a little spread along a plane intermediate between *ac* and *bc* (Fig. 1*a*). The specimen, coming as it does, from a region beyond an appreciable direct influence due to the intrusion of the porphyritic granite, shows the original fabric of the country rock, only slightly affected, if at all, by the intrusion.

The maximum in the first diagram lies close to the maxima VI and VII of the synoptic diagram (Fairbairn, 1944). It will be seen from the diagram (Fig. 1*c*) that the obtuse bisectrix of the intersecting shear joints, which has been recognised as the direction of compression (Sen, 1949) contains the maximum and is situated centrally about the distribution or the scattering of the axes.

The peripheral *ac* girdle is the original tectonitic fabric. The compressive force due to the intrusion of the granite, acting in the direction of the obtuse bisectrix of the conjugate shear planes, re-oriented the fabric, without, however, affecting the original *ab* plane. The fabric has been totally reconstituted, the original *ab* plane controlling the orientation. The maximum, on these premises, is really equivalent to maximum III of the synoptic diagram. The grains were ground mechanically, with the needle axes of the ruptured grains parallel to the horizontal edge (*m* : *r*) and with their unit rhombohedral bounding face lying in the original *ab* plane (Griggs and Bell, 1938). This suggestion of mechanical rupturing of the grains is not altogether conjectural or contrary to evidences. Indeed effect of cataclastation is clearly shown by mylonitic gneisses which are quite common along the wall. "With the ruptural stage predominant in the deformation (which came to an abrupt closure) the original *ab* plane remained in tact and served as the *structure control plane* for the reconstituted fabric. The grains were fractured and the axes gathered from their original disposition (a peripheral *ac* girdle) towards the *maximum* or in other words, the needle axes were rotated parallel to *a*" (Sen, 1949).

Darjeeling.—The quartz axes fabric of rocks from successive metamorphic zones, sandstones from the Tertiaries and Gondwana and specimens from the garnet and the kyanite zones were studied. The fabric of the successive stages reveal a progressive character which is significant. In a specimen from the garnet zone two *ac* girdles are found (Fig. 2*d*), one approximately 35° round *b* and the second peripheral. The first breaks up and joins with the peripheral girdle. In the higher grades the small *ac* girdle has been pushed off and only the peripheral girdle appears. The sandstones show a more perfect small *ac* girdle with only an incipient peripheral one. There is on the whole a discernible tendency for the higher grade rocks to show a more and more perfect equatorial *ac* girdle at the expense of the smaller one. The explanation put forward was that the smaller girdle is the original non-tectonitic fabric which thus appears better in the underformed Tertiaries. Ingerson and Raimisch had already found a similar small *ac* girdle in Siwalik sandstones, which they ascribe to an elongation of the clastic quartz grains parallel to (1011). This fabric was at first broken down (Fig. 2*c*) so that beyond the complete blank 30° round *b* the quartz axes were almost equally dispersed upto the periphery. Further deformation pushed forward the axes more and more to the equatorial zone as seen in the fabric of the specimen from the kyanite zone (Fig. 1*e*) which shows a perfect peripheral *ac* girdle, with a slight tendency to spread into a *bc* girdle.

A beautiful field evidence of the above explanation has been found recently from the fabric of a Gondwana sandstone (Fig. 2*b*) coming from a local shear zone. It is seen that, though the Gondwanas show a very strong small *ac* girdle, the above specimen lacks any distinct girdle in that region, the one round the periphery being prominent, though there are a good number of axes round the 35° zone giving a semblance of the original fabric. Within the peripheral *ac* girdle there are maxima closer to *a*. A careful study of the sheared quartz grains from the same specimen reveal lamellæ in the quartz which have an orientation parallel to a horizontal edge. The lamellæ have been developed in grains whose axes fall beyond 35° zone. These are seen only in highly sheared quartz grains. This may lead to the reasonable assumption that the lamellæ formed in response to the deformation, by translation along an horizontal edge, most

probably $m : r$ (Fairbairn, 1939). The shifting of the girdle to the periphery has, thus, been performed by deformation gliding in a direction parallel to m: r, the translation might have occurred in any plane. The original fabric being interpreted as due to the needle axes of the clastic quartz grains lying parallel to c and bounded by unit rhombohedron, the presence of the *maxima* close to a (Fig. 2b) and the general position of the *maxima* within the small girdle, suggest a translation along a plane chiefly parallel to r.

Chaibassa.—The two specimens studied by Saha were not oriented in the field. One of these shows a normal peripheral ac girdle.

In the case of the second, in the small hand specimen, no distinct lineation in the ab plane was visible to help fixing up the b direction with certainty. The b fabric axis might have been recognized and marked out in the field, parallel to the regional tectonic strike or to some other local features like puckering and folding that might have been present, but which might have been too broad to come out in the hand specimen. Since nothing had been done in the field the interpretation has to be conjectural. In the ab girdle there are two *maxima* diametrically opposite. This direction has been taken to be parallel to a. For the girdle, I suggested an orientation by mechanical flattening in a deformation that was triaxial, causing an equivalent distribution close to a and b (Fig. 3a), the greater elongation parallel to a causing the *maxima* there. The ab girdle may, however, find other explanations. The somewhat cataclastic texture of the quartzites may support a suggestion of orientation by fracturing. There might have been, thus, a fracturing and rotation of the grains with their (1010) needle faces rotated parallel to ab and the needle axes parallel to c lying in any direction on ab. The explanation for the *maxima* near a is as above. The explanation may also lie in the manner of fracturing, with the needle axes parallel to c and also to the horizontal edge $m : r$ with the larger percentage having the former orientation. The distribution of axes round four zones as seen in the Figure (3a) may support this suggestion. Since, however, only 60 axes were measured, the distribution may give a false picture and the true fabric may be more or less a complete ab girdle. In such a case as the last mechanism does not explain the girdling, the former explanations seem more plausible. Whether the orientation was by fracturing and subsequent rotation, or by mechanical flattening, perhaps by translation, is difficult to be sure of, and a more detailed work is necessary.

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CARBON DIOXIDE ISOTOPES

Infra-red spectra of the sun studied at the McMath-Hulbert Observatory, University of Michigan, have revealed the presence in the earth's atmosphere of carbon dioxide made up of the less common isotopes of carbon and oxygen. These are carbon of atomic weight 13 (C^{13}) and oxygen of atomic weight 18 (O^{18}).

The isotopes of carbon dioxide, found by Drs. Leo Goldberg, Orren C. Mohler and Robert R. McMath, are $C^{13}O^{16}O^{16}$ and $C^{12}O^{16}O^{18}$, detected in several relatively faint band structures.

In view of the difficulties that arise in the comparison of the intensities of very strong and very weak absorption lines, it is not possible at present to derive accurate isotope abundances from the line intensities. But the relative intensities of these carbon dioxide isotopes appear to be consistent with the generally accepted abundances of C^{13} and O^{18}, which are respectively 1·1 per cent. and 0·20 per cent. of the more abundant isotopes of these two elements.—(By courtesy of *Sky and Telescope*, 1949, VIII, p. 124).

OXIDATION OF LAC BY LEAD TETRAACETATE

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(Department of Chemical Technology, University of Bombay)

SINCE the introduction of lead tetraacetate as a specific oxidizing agent for adjacent hydroxyl groups in organic compounds by Criegee,[1] numerous investigators have used this reagent for establishing the constitution of a number of organic substances, particularly carbohydrates. A solution of lead tetraacetate in glacial acetic acid has also been employed for the quantitative estimation of substances containing adjacent hydroxyl groups like glycerine, monoglycerides, sugars, etc.[2–5]

The possibility of lac resin containing free adjacent hydroxyl groups has been advanced by Bhattacharya.[6,7] The constitution of aleuritic acid,[9,10] trihydroxypalmitic acid, the chief constituent of lac,[8] was confirmed by the work of Raudnitz, *et al.*[9] who used lead tetraacetate for its oxidative degradation. Gidvani and Bhattacharya[10] have studied the oxidation of lac by red lead in glacial acetic acid but the work was confined to the possibility of utilising the oxidized lac for industrial purposes. As the confirmation of the possibility of free adjacent hydroxyl groups being present in lac will considerably help in understanding some of the reactions peculiar to lac resin, it was considered desirable to study the oxidation of lac by lead tetraacetate.

In addition to lead tetraacetate, periodic acid and potassium periodate have also been employed as specific oxidizing agents for adjacent hydroxyl groups; while some work has been carried out with these reagents for the oxidation of lac, preliminary experiments showed that lead tetraacetate is to be preferred, as the solvent for the reagent happens to be an excellent solvent for lac also.

The lead tetraacetate was prepared according to the method recommended by McClenahan[11] and was stored in an airtight container, kept under anhydrous conditions. As a solution of lead tetraacetate in glacial acetic acid continuously decomposes to the more stable diacetate, the reagent was always freshly prepared; further in view of its limited solubility, only dilute solutions of the reagent could be employed and throughout the present work approximately decinormal solutions have been used.

In order to find out the optimum conditions of oxidation a series of experiments were carried out and the effect of time, dilution, type of solvents and excess of reagent required were systematically studied. In all cases oxidation was carried out at room temperature in order to avoid secondary reactions which are known to occur at higher temperatures. Briefly the method consisted in dissolving a known amount of lac in a known volume of glacial acetic acid, adding the requisite quantity of the reagent and keeping it in the dark for a known period of time. The quantity of reagent consumed was determined by standard iodometric titration. A blank experiment without lac was also carried out at the same time. The results are expressed as milligrams of potassium hydroxide per gram of the substance in order that a comparison can be made with the hydroxyl values.

In the preliminary experiments a commercial lac was employed. Lac was ground to 40 mesh, washed with cold distilled water until free from water-soluble substances, filtered, air-dried for 24 hours and then vacuum dried over a solid dehydrating agent at room temperature for 24 hours, and stored in an airtight glass container. The results obtained with this lac are given in Tables I, II, and III.

TABLE I

Effect of time

Weight of lac 0·1000 ± 0·0020 g. Glacial acetic acid for dissolving lac 5 ml. Amount of reagent used 10 ml.

Serial No.	Time in minutes	Lead tetraacetate value mg. KOH/g.
1	5	45·5
2	5	46·23
3	10	48·63
4	10	49·04
5	20	48·53
6	30	51·69
7	60	57·89
8	60	58·24
9	120	58·14
10	24 Hours	57·51

From the results given in Tables I, II and III, it can be seen that the maximum values are obtained when 0·1 g. lac, dissolved in 5 ml. of glacial acetic acid is treated with 10 ml. of the reagent for 60-120 minutes. Addition of solvents like carbon tetrachloride or increasing the quantity of glacial acetic acid, lac, or time beyond two hours,

gives values which are comparatively lower. The following method, therefore, can be recommended for determining the lead tetraacetate value of lac resin.

TABLE II

Effect of varying the volume of solvent

Weight of lac 0·1000 ± 0·0020 g. Amount of reagent used 10 ml. Reaction time 60 minutes

Serial No.	Volume of glacial acetic acid ml.	Lead tetraacetate value mg. KOH/g.
7	5	57·89
8	5	58·24
11	10	51·69
12	10	51·18
13	20	40·13
14	20	41·77
15*	4	57·68
16*	4	57·44

* Contains 1 ml. of carbon tetrachloride in addition to the 4 ml. of glacial acetic acid.

TABLE III

Effect of varying the quantity of lac

Amount of glacial acetic acid for dissolving lac 5 ml. Amount of reagent 10 ml. Reaction time 60 minutes

Serial No.	Weight of lac g.	Lead tetraacetate value mg. KOH/g.
7	0·1004	57·89
8	0·0998	58·24
17	0·2010	56·38
18	0·2002	55·20
19†	0·5006	47·60
20†	0·5004	47·61
21†	1·0008	42·39
22†	1·0060	41·27

† Contains 5 ml. of carbon tetra chloride in addition to the 5 ml. of glacial acetic acid.

All chemicals should be of the purity recommended by the B.S.S. No. 954-1941 for determination of the iodine value of lac. The reagent itself should be prepared according to the method recommended by McClenahan[11] unless a pure grade is available. The solution of lead tetraacetate should be matured for at least 24 hours before using.

Place 0·1 g. lac in a well stoppered flask, either 250 ml. or 300 ml., and dissolve in 5 ml. of glacial acetic acid by gently warming if necessary. When lac has dissolved, cool the solution to room temperature and add 10 ml. of 0·1 N lead tetraacetate solution and keep the flask in the dark for exactly 60 minutes with occasional agitation at room temperature. Then add 20 ml. of a 10 per cent. solution of potassium iodide and titrate the iodine liberated with 0·1 N sodium thiosulphate, using starch as indicator. The end point obtained is sharp; if the colour returns after 30 seconds, it should be disregarded. A blank experiment shall be carried out with all reagents in the same manner.

The lead tetraacetate value is given by the expression:—Lead tetraacetate value

$$= \frac{\text{(ml. thiosulphate for blank-ml. thiosulphate for lac)}^{*}}{\text{Weight of lac}}$$

* Normality of thiosulphate × 56·1.

Using this method, the lead tetraacetate values of a number of samples of commercial lacs as well as some authentic samples of lac have been determined and the results are given in Table IV.

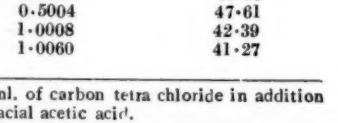
TABLE IV

Lead tetraacetate values of lac

Type of lac	Lead tetraacetate value mg. KOH/g.
* Shellac (waxy) ..	65·26
* Light yellow coloured shellac ..	54·24
* Dewaxed decolourised shellac ..	56·92
* Dark coloured dewaxed shellac ..	77·27
Washed seedlac ..	54·25
Dewaxed seedlac ..	47·65
Ether-insoluble portion of dewaxed seedlac ..	52·52
Ether-soluble portion of dewaxed seedlac	48·0

* Commercial samples of lac

As lead tetraacetate oxidizes not only



groupings, definite conclusion regarding the presence of any specific grouping can only be established by an examination of the products of oxidation and work along these lines is now under progress.

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A NEW SUM RULE FOR THE MULTIPLET SPECTRA

RECENTLY a simple wave statistical representation of the spin motion has been developed by Kar-Sengupta[1] and Sengupta.[2] This representation has been applied to calculate the energies and intensities of doublet and multiplet spectra. The results thus obtained are in perfect agreement with those obtained by other well-known methods. In developing the theory of complex spectra, a new sum rule analogous to the well-known Γ- and g-sum rules has incidentally been obtained. It has been called the δ-sum rule and is applicable to the electrostatic interaction energies. It has been shown[3] that the sum of the electrostatic interaction energies of all terms of same M value, arising out of any configuration of N electrons, is given by

$$\sum_{k>l=1}^{N} \sum E_{n_k n_l} \qquad (1)$$

where

$$E_{n_k n_l} = \int\int \chi_{n_k}(i)\, \chi_{n_l}(j)\, \frac{e^2}{r_{ij}}\, \tilde{\chi}_{n_k}(i)\, \tilde{\chi}_{n_l}(j)\, d\tau - \int\int \chi_{n_k}(i)\, \chi_{n_l}(j)\, \frac{e^2}{r_{ij}}\, \tilde{\chi}_{n_k}(j)\, \tilde{\chi}_{n_l}(i)\, d\tau$$

and n_k, etc., stand for the complete set of quantum numbers $n_k\, l_k\, m_{l_k}\, m_{s_k}$, etc. The first Σ in (1) means summation over all possible values of $(m_{l_1}\, m_{s_1};\ m_{l_2}\, m_{s_2};\ \ldots\ldots\ m_{l_N}\, m_{s_N})$, consistent with the condition,

$$\sum_{k=1}^{N} (m_{l_k} + m_{s_k}) = M.$$

From (1) it is evident that the sum of the electrostatic energies of all terms of same M value, is independent of both the coupling strength and magnetic field strength. This gives the δ-sum rule for all field. In case of weak magnetic field, this rule states, as can be easily shown, that the sum of the electrostatic energies of all terms of same J value, arising out of a given configuration

is independent of coupling. The detailed consideration of the rules and their theoretical derivation are given in another paper to be published elsewhere. It may be interesting here to illustrate the rule by considering the special case of np^3-configuration. In this case the allowed terms are $^2D_{5/2}$, $^2D_{3/2}$, $^2P_{3/2}$, $^2P_{1/2}$, $^4S_{3/2}$. From the δ- and Γ-sum rules we easily get,

$$\left.\begin{aligned} {}^2D_{5/2} &= 3F_0 - 6F_2 = I \\ {}^2D_{3/2}+{}^2P_{3/2}+{}^4S_{3/2} &= 9F_0-21F_2 = II \\ {}^2P_{1/2} &= 3F_0 \qquad\quad = III \end{aligned}\right\} \qquad (2)$$

where F_0 and F_2 are the well-known Slater-Condon notations.[4] On eliminating them from (2) we at once get,

$$\sigma = \frac{III + 2\,II}{7\,I} = 1. \qquad (3)$$

Since the sums given in (2) are independent of coupling, the relation (3) will evidently be true in all coupling strength. In the following table we give the experimental values of σ for a number of cases, calculated from the data taken from Bacher and Goudsmit.[5]

TABLE

Element	Configuration	σ
Theoretical	np^3	1·00
7 N I	$2p^3$	1·01
7 N III	$2p^3$	0·94
8 O II	$2p^3$	0·71
16 S II	$3p^3$	0·99
33 As I	$4p^3$	1·00
51 Sb I	$5p^3$	1·02
85 Bi I	$6p^3$	0·97

The nature of coupling from 7N I→85 Bi I varies widely. In spite of this, the experimental values of σ are in agreement with the theoretical value 1 in all cases. This is, obviously, a striking confirmation of the δ-sum rule deduced from the wave statistical theory.

It is not possible to eliminate the constants and obtain a ratio similar to (3) for all configurations. This is possible only for cases where the number of equations given by the sum rule is greater than the number of constants involved. Thus for p^3s, d, d^3, etc., configurations such elimination is possible. But since sufficient data are not available for these cases, no useful comparison with the experimental results can be made.

The proposed δ-sum rule, it is hoped, will prove of great help in the classification of different spectra, specially those in the intermediate coupling region.

My best thanks are due to Prof. K. C. Kar, D.Sc., of Presidency College, Calcutta, under whose guidance the work has been conducted.

Physical Laboratory, S. SENGUPTA.
Presidency College,
Calcutta,
May 16, 1949

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ON THE DERIVATION OF A GENERAL EQUATION OF ENZYME-KINETICS

IT has already been shown that the laws of enzyme-kinetics can be deduced from elementary considerations of the Resonance Theory previously proposed by the author (*Curr. Sci*, 1945, 14, 261).

In fact it was shown (*Curr. Sci*, 1946, 15, 130) that

$$y = S\{1 - (1 - KE)^n\},$$

where

y= Concentration of products at time t.
S= Substrate concentration (initial).
n= number of cycles performed by the enzyme molecules in course of the time t that has elapsed.

We have then put $n = At$, where 'A' is a constant and deduced the various laws for enzyme kinetics.

But it stands to reason that the different time-periods of the cycles (*Curr. Sci.*, 1946, 15, 130) τ_1, τ_2, τ_3 ..... (1, 2, 3, ..representing the first, second, third cycle respectively) may not all be equal, *i.e.*, when the substrate concentration becomes dilute, the time for energy exchange from the enzyme to the substrate molecules may not remain the same but be longer as the dilution is increased. We may in other words say that the time period of any one cycle is inversely proportional to the substrate concentration at that time

or,

$$\tau_1 = B/S$$

$$\tau_2 = \frac{B}{S - KES} = \frac{B}{S(1 - KE)}$$

$$\tau_3 = \frac{B}{S(1-KE)^2} = \frac{B}{S(1-KE)^2}$$

. . . . . .

. . . . . .

and so where 'B' is constant.

The total time t is made up of all these time periods or is $= \tau_1, \tau_2, \tau_3 \ldots\ldots n$ terms where n is the number of cycles.

$$t = \tau_1 + \tau_2 + \tau_3 \ldots\ldots n \text{ terms}$$

or

$$t = \frac{B}{S} + \frac{B}{S(1-KE)} + \frac{B}{S(1-KE)^2} + \ldots\ldots n \text{ terms}$$

$$= \frac{B}{S}\left[1 + \frac{1}{1-KE} + \frac{1}{(1-KE)^2} + \ldots\ldots n \text{ terms}\right.$$

$$= \frac{B}{S}\left\{\frac{\left(\frac{1}{1-EK}\right)^n - 1}{\frac{1}{1-EK} - 1}\right\}$$

Putting a for $\frac{1}{1-EK}$,

$$a^n - 1 = \frac{St(a-1)}{B}$$

or
$$a^n = 1 + \frac{St(a-1)}{B}$$

or
$$n = ln \frac{\left[1 + \frac{St(a-1)}{B}\right]}{ln\, a}.$$

But we have the relation,

$$y = S\{1 - (1-KE)^n\}$$

or,
$$\frac{S-y}{S} = (1-KE)^n$$

or
$$ln \frac{S-y}{S} = n\, ln\,(1-KE).$$

Substituting the value of,

$$n = ln \frac{\left[1 + \frac{St(a-1)}{B}\right]}{ln\, a}$$

we get

$$ln \frac{S-y}{S} = ln \frac{\left[1 + \frac{St(a-1)}{B}\right]}{ln\, a} \times ln\,(1-KE)$$

But

$$a = \frac{1}{(1-KE)}.$$

Therefore,

$$ln\, a = ln\, 1 - ln(1-KE) = -ln(1-KE)$$

or,

$$ln \frac{S-y}{S} = ln \frac{\left[1 + \frac{St}{B}\frac{KE}{(1-KE)}\right]}{-ln\,(1-KE)} \times ln\,(1-KE)$$

or,

$$\frac{S}{S-y} = 1 + \frac{St \cdot KE}{B \cdot (1-KE)}$$

or

$$\frac{S}{S-y} - 1 = K_2 \cdot St \left[\text{const. } K_2 = \frac{KE}{B(1-KE)}\right]$$

or,

$$\frac{y}{S-y} = K_2 \cdot St$$

i.e.,

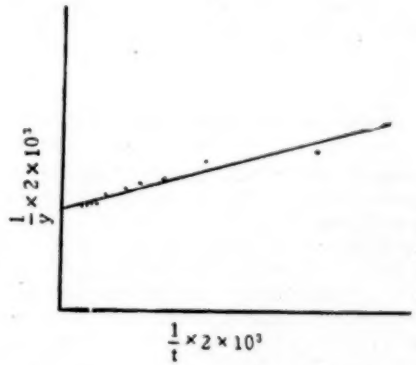

FIG. 1. Enzyme-β-amylase. Substrate—potato amylose precipitated by Butanol (not autoclaved).
From Jelinek and Harrison, *Biochem. J.*, 1918, **43**, 32.

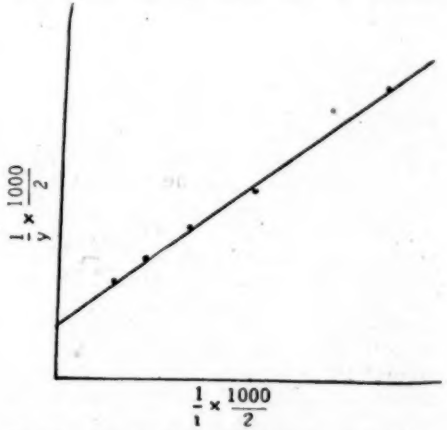

FIG. 2. Enzyme-Lipase. Substrate—monostearin.
From Balls, Matlack and Tucker, *J. Biol. Chem.*, 1937-38, **122**, 129.

$$\frac{S\cdot(S-y)}{y}=\frac{1}{K_2}\cdot\frac{1}{t}=\frac{K_3}{t}\text{ where }K_3=\frac{1}{K_2}\cdot$$

or,

$$\frac{K_3}{t}=\frac{S^2}{y}-S.$$

That is, if our proposition is correct, a straight line will be obtained when $1/t$ is plotted against $1/y$ (Figs. 1 & 2). Practically all the important enzymes with uncomplicated reactions have been found to show this relation, for example, phosphatase, amylases (α and β), proteinases, lactase, lipases, etc. The detailed study will be published elsewhere.

A. K. Rai Chaudhury.

Bose Research Institute,
Calcutta, *June* 28, 1949.

ELASTIC CONSTANTS OF LITHIUM FLUORIDE

Among the alkali halides which show a remarkable gradation in all their physical properties, lithium fluoride is an exception in many ways. The elastic constants of the substance have been determined by Schæfer and Bergmann by the ultrasonic method of setting the crystal itself into vibrations and then using it as a three-dimensional grating to a beam of light. In view of the exceptional behaviour of the substance, it was considered desirable to repeat the measurements by other ultrasonic methods and the results of the investigation are given below:—

Lithium fluoride crystallises in the regular cubic class and has an easy cleavage parallel to the cube face. The sample used in the present investigation was artificially grown and supplied by Harshaw Chemical Company, Ohio, U.S.A. Sections (100) and (110) of different thickness (1·275-1·5 mm.) have been cut and used for the measurements. The acoustic velocities in these plates were determined by both the ultrasonic wedge method developed by Bhagavantam and Bhimasenachar (1941) and the modified plate method described by the author (1948), the frequencies used ranging from 1 to 12 mc./sec. The elastic constants were evaluated from the mean acoustic velocities. The results are given in the following table. The elastic constants c's and the bulk modulus K are given in units of 10^{11} dynes/cm.^{2} and the elastic moduli s's in units of 10^{-13} cm.^{2}/dyne. The density of the substance is taken as 2·601 gm./cm.^{3}

No.	Observer	c_{11}	c_{12}	c_{44}	s_{11}	s_{12}	s_{44}	K
1	Schaefer & Bergmann	11·8	4·34	6·28	10·6	−2·85	15·9	6·82
2	Author	11·9	4·58	5·42	10·7	−2·97	18·5	7·02
3	Bridgman	..	..	..	..	..	..	8·55

In the above table, the value of K obtained experimentally by Bridgman and those calculated from the relation.

$$K=\tfrac{1}{3}(c_{11}+2c_{12})$$

are entered in the last column.

It can be seen from the table that for c_{11} and c_{12} the values obtained by the author are in good agreement with those of Schæfer and Bergmann. For c_{44}, on the other hand, the two values differ by about 16% which is far beyond the usual experimental error. It is not possible to give any explanation for this discrepancy. However, it is interesting to point out that the author's values are in better agreement with the theoretical Cauchy relationship, *viz.*, $c_{12}=c_{44}$ for cubic crystals, which is found to hold good to a very great extent in the case of alkali halides.

The author thanks Prof. R. S. Krishnan for his kind interest in the work.

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Department of Physics,
Indian Institute of Science,
Bangalore, *July* 8, 1949.

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KATABATIC EFFECT OVER JODHPUR

Jodhpur is situated on the eastern edge of the Thar desert about 20 miles from the Luni river which remains dry during the greater part of the year. The nearest distance from the sea is about 270 miles to the S W. The Aravalli range running NE to SW lies SE of the station at a distance of about 70 miles. Parts of the range are as high as 2,700 ft. or over. The NE end of the range descends into the desert and the SW edge is terminated abruptly at a point slightly over 120 miles south of the station near

Mt. Abu (elevation 5,650 ft.). To the North and West of the station is the semi-desert region of Jailsulmer and to the SW is the Thar Parkar region.

To the South and SSE of the airfield there is a slight downslope for about 20 miles to the Luni river. Beyond this, in the same direction, is the gradual upslope to some rolling and scattered rocky hills at a distance of 50 miles. To the SE and E is a gradual upslope to the foothills of Aravalli range followed by rapidly increasing upslope at the range. Close by in the North and West are scattered low rocky hills; to the WSW is gradual downslope to the Luni river system.

During the months of Dec. to Feb. Katabatic drainage of air from the high ground E and SE of the station is perceptible under the following conditions: (*a*) feeble pressure gradient, (*b*) clear or lightly clouded sky with dry air permitting radiation-cooling during the night. The prevailing wind over Jodhpur in winter, specially during second half of the night is dry NEly. The ground temperature starts falling rapidly after sunset becoming steady later during the night. The thermograph would have shown a smooth curve with a rapid fall at sunset and gradual stratification later, if the country were a perfect plain in the neighbourhood of Jodhpur, but due to the drainage of air from the hills in SE, there are kinks on the curve of thermograph. The kinks are followed by change in wind direction or speed and confirm the idea of Katabatic drainage from the hills.

Over the hills, cold air is collected in valleys and depressions and when during the night further cooling takes place it overflows as Katabatic wind. This Katabatic motion takes place under simple gravitational effect. When the conditions get out in para 3 are satisfied Jodhpur experiences a marked ground inversion and consequently the influx of colder air from the hills. From the photographs of anemograms and thermograms of the days when the flow was active it is gathered that when the change in wind takes place there is generally a fall of temperature by 2 to 4 deg. F. or even more at times. However, there are instances of rise in temperature by one or two deg. F. in advance of Katabatic flow. This may be due to sudden impingement of Katabatic wind upon the stratified layer of air which causes a temporary mixing or churning up and consequent rise of temperature. But the net result of Katabatic effect seems to be cooling.

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Karachi, *July* 19, 1949.

*A NOTE ON PERFORATED CATHODE SELF-QUENCHING G.-M. COUNTERS

IN self-quenching Geiger-Muller counters the slope of the plateau has been attributed by Korff and Present (1944), to the occurrence of multiple pulses which are counted as spurious counts. The multiple discharges in a counter are produced either by photoemission, that is, a photon of sufficient energy falling on the cathode ejects an electron which in turn produces a multiple pulse or by the positive ions, which, on reaching the cathode attract an electron again giving a multiple pulse. Quenching vapour has a dual role of neutralising the positive ions and absorbing the photons, though Craggs and Jaffe (1947) have shown that the absorption of photons capable of ejecting electrons from the cathode in self-quenching counters is not complete. There will thus be a certain number of spurious counts due to the photons. Also, at higher potentials the average energy and the number of positive ions being greater (Stever, 1942), there is an increase in the number of ions reaching the cathode resulting in greater secondary emission and a corresponding increase in the frequency and the multiplicity of the multiple pulses. The slope of the plateau is thus to be attributed to the increasing frequency and multiplicity of the pulses, leading to an increase in the number of spurious counts. (Putman, 1948; Wilson and Carson, 1948.) Putman has further shown that the spurious counts, which are due to secondary electrons liberated from the cathode by the positive ions are the major cause of the plateau slope in argon-alcohol filled counters.

In order, therefore, to have a good counter *i.e.* having a long and flat plateau (Korff, 1948) so that the counting rate remains constant even when there are large variations in the voltage applied, we must reduce the number of multiple discharges or the spurious counts. Putman has used an external quenching circuit which renders the counter inoperative after each count for a period greater than the recovery time, thus obtaining a significant increase in the flatness of the plateau.

In the present investigation we have, however, tried to reduce the number of multiple pulses in another way. It was thought that for a given size of the counter, if we reduce the surface area of the cathode, the chance of multiple pulse being produced by the photons or by the positive ions will decrease, roughly in proportion to the decrease in the area of the cathode. A counter of this type should therefore have a more flat plateau without the use of an external quenching circuit. To verify this idea two counters, out of a large number, of nearly the same dimensions (18 cm. long, 2·3-2·4 cm. diameter) one with a thin copper sheet cathode and the other with copper gauze cathode (40 meshes per inch) filled simultaneously under similar conditions at 8·5 cm. of commercial argon and 1·5 cm. of alcohol (100% pure) to a total pressure of 10 cm. of mercury, were chosen. The counting rate-voltage curves were obtained for the two counters, employing a simple circuit using a 57 tube and a 6L6 tube for working the mechanical recorder (cyclotron specialities) capable of recording 60 pulses per second. The curves are shown in Fig. 1.

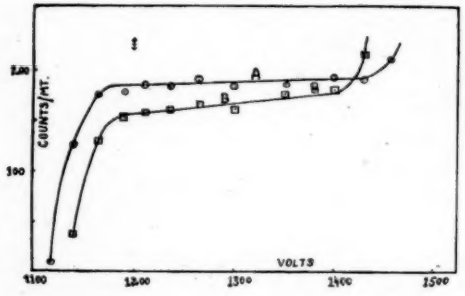

FIG. 1. Showing the Plateau curves for (A) Gauze cathode and (B) Sheet cathode counters. The arrow shows the extent of probable error.

It is clear that the plateau is definitely longer and more flat in the case of a gauze counter (plateau length, 250 vols and practically zero slope) while for the other, the plateau is smaller (210 volts) and has a considerable slope about ·06% per volt. The pulse size in the two cases was observed on the oscillograph screen and it was found to be the same in two cases, *i.e.*, the nature of the cathode has no effect on pulse size. A gauze counter is therefore an improvement as it dispenses with the use of an external quenching circuit for getting a flat plateau. How far the gauze reduces the number of spurious counts will be definitely decided by a study (which is under progress) of the spurious pulses in the two cases. Further it may be pointed out that gauze cathode counter can be specially useful in the study of β rays where we need cathodes of practically zero thickness.

In the end the author wishes to thank Dr. P. L. Kapur, Reader in Physics, Delhi University, for his able guidance and interest in this work. Without his help this work would not have been possible. The author is also thankful to his student, Mr. S. K. Suri, M.Sc., now research officer in the National Physical Laboratory, Delhi, for helping in the initial stages of the experiment.

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Government College, Hoshiarpur, (E. P.), *July* 11, 1949.

* The present work was completed in the Delhi University Physics Laboratory, Delhi.

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THE BAND SPECTRUM OF CHROMIUM BROMIDE

A GROUP of 16 bands (Plate A) attributable to the diatomic molecule CrBr, similar to those of CrCl,[1] is obtained in the region λ 6200-λ 6310 in a H. T. generator discharge through the vapour of specially prepared chromium bromide in a quartz discharge tube described elsewhere.[2] The band head data are listed in Table I, which shows also a few regularities observed among the heads. Analysis of the bands is not possible: the recurring interval of 50 cm^{-1} might represent the characteristic and expected multiplet separation in CrBr corresponding to 40 found in CrCl previously.[2] The entire group may represent the $\Delta v = 0$ or 1 sequence. The low intensity of the bands frustrated all attempts to obtain them under higher dispersion, to facilitate a complete analysis.

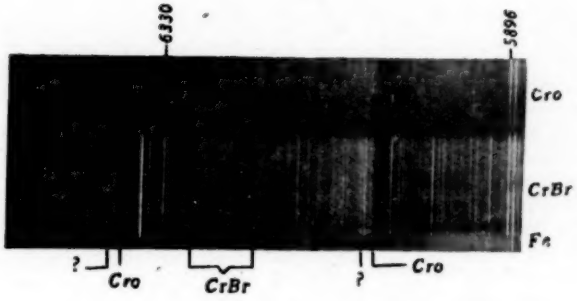

PLATE A

Chromium Bromide Bands—Glass Littrow

TABLE I

Catalogue of Cr Br Bands

Wave-length	Intensity	Wave-number	Regularities
6422·0	1	15567	?
6469·4	1	15598	
6399·8	1	15621	
6308·9	1	15846	
6301·4	2	15865	52
6296·8	2	15877	
6292·8	1	15887	54
6289·8	1	15894	53
6280·7	2	15917	
6275·4	2	15931	
6272·0	2	15940	51
6267·0	2	15952	
6251·8	1	15991	51
6247·2	1	16003	
6243·7	1	16017	
6238·1	2	16026	
6215·6	0	16084	
6211·8	1	16094	
6198·8	2	16128	
6136·8	1	16291	?

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Physics Department,
Andhra University,
Waltair, *July* 12, 1949.

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TOURMALINE FROM DEVARNARSIPUR, BHADRAVATI, MYSORE

IN studying an interesting type of Chlorite-Tourmaline rock from Devarnarsipur, Sri. M. G. C. Naidu has examined the Chlorite and identified it as Amesite.[1] The tourmaline of the rock mentioned as Schorlite, has now been taken for detailed study.

Under the microscope the tourmaline appears as long blades with criss-cross texture. Some rounded basal sections also occur. The colour is pale blue, and easily distinguished from the associated, pale-green, scaly amesite.

The following are the optical characters of the mineral:—

Negative Elongation

Absorption parallel to vertical cross wire O>E

Optically Negative.

Birefringence, $\omega - \varepsilon = 0{\cdot}026$ (determined by Bereck's Compensator)

Indices of refraction $\varepsilon = 1{\cdot}630$ $\omega = 1{\cdot}655$

Distinct dichroism. X (E) = Colourless
Z (O) = Pale Blue.

The chemical composition was computed from the Variation diagram as given by Winchell.[2] This shows the tourmaline to be an isomorphous mixture of,

36 p.c. of Schorlite
$[H_8Na_2\ (Fe, Mn)_6\ B_6\ Al_{12}\ S_{12}\ O_{62}]$
64 p.c. of Dravite
$[H_8Na_2Mg_6B_6Al_{12}Si_{12}O_{62}]$
in the proportion of 4 : 7 approximately.

Giovanni D' Achiardi[3] has noted that the variation in the colour of tourmalines varies

with axial ratio. For example, the lowest value of axial ratio, 0·441154, is for yellow-green tourmalines, and the highest value, 0·454079, is for the yellow-tourmalines. Since crystals with the rhombohedral terminations are not found in the tourmaline under study, it is not possible to calculate its axial ratio. Therefore its relation to the colour cannot be determined.

Guido Carobbi and Renzo Pieruccini[4] correlate the colour of tourmalines with the value of double refraction; as for example $\omega-\varepsilon=0{\cdot}0200$ is associated with pink, 0·0204 with colourless, and 0·0220 with greenish-yellow tourmalines. Here the value is 0·0255 and according to Winchell, this is towards the green and the blue tourmalines.[5]

From the spectrographic study, they find that lithium and copper are present in almost all samples of tourmalines from the Island of Elba and that the latter is greater in quantity in the blue crystals. As regards the blue crystals from Elba, it is suggested that copper and lithium substitute for magnesium as an isomorphous substitute. It also stated that copper in minute traces is a common substitute for the isomorphous group Mg-Fe" in the silicates of the rocks. It is therefore suggested that in the tourmaline under study, lithium and copper have substituted the Mg-Fe" of a Ferro-Magnesium mineral.

Scharizer[6] and T. W. Warner[7] have attributed that the change in colour of tourmaline is mainly due to the presence of minor constituents. G. Carobbi and R. Pieruccini state that the blue colour of tourmaline is due to the presence of copper and particularly due to the strongly deforming action of Cu".

The sample of the tourmaline under study was kindly analysed spectrographically by Dr. R. S. Krishnan, Department of Physics, Indian Institute of Science, Bangalore, and showed the following elements:

B, Si, Al, Fe, Mg, Cu, K, Na, & Li.

Winchell classifies the tourmaline series into Dravite-Schorlite and Schorlite-Elbaite series, the distinction between the two series being based on the presence of lithium in the Schorlite-Elbaite series and the absence of it in the Dravite-Schorlite series. Accordingly Dr. C. S. Pichamuthu[8] describes a tourmaline from Yenneholeranganbetta as belonging to the Schorlite-Elbaite series. In regard to colour, Winchell distinguishes the Dravite-Schorlite series as being brown, less commonly blue or green to black; and Schorlite-Elbaite series as black to delicate tints of pink, green or yellow.

Since according to the analysis of Dr. Krishnan, a persistent line of lithium has been indicated at λ6708Å the tourmaline of Devarnarsipur must be regarded after Winchell as belonging to the Schorlite-Elbaite series. But on the basis of the scheme of colour given by him, it should be put into the Dravite-Schorlite series. In view of the fact that T. W. Warner and G. Carobbi have now recently shown that lithium is present in all tourmalines and cannot therefore be a distinguishing criterion for classification, it is obvious that on the basis of the colour scheme the Devarnarsipur tourmaline should be placed in the Dravite-Schorlite series. This view is also in accordance with the fact that the copper is replacing the Mg-Fe" of the mineral and gives the blue colour associated with the Dravite-Schorlite series.

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Central College,
Bangalore, *July* 6, 1949.

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CHEMISTRY OF SUGARCANE JUICE IN RELATION TO MANUFACTURING QUALITIES—A STUDY WITH SPECIAL REFERENCE TO THE OPEN PAN INDUSTRY

THE important bearing of non-sugars on the manufacturing qualities of sugarcane juices is familiar in vacuum pan practice. Kortscher[1] discusses the injurious effects of various organic non-sugars in the colloidal state and Alvarez[2] connects superior factory quality with smaller amounts of gums and albuminoids. The so-called "harmful" nitrogen compounds[3], comprising amino acids, organic bases etc., are commonly regarded as very undesirable. Various evil effects are also attributed to different mineral constituents, such as Silica, iron, alumina and magnesia [2,4]. Gomez and Boon[5] mention the existence of silica in the form of soluble sili-

cates as well as complex organo-siliceous compounds, the later class being also recognised by Muller.[6] Davis[7] makes the definite observation that organic silica is inversely proportional to juice "claribility". The question of phosphates has engaged the attention of workers in many countries, with particular reference to the variety POJ 2878, the manufacturing difficulties commonly observed being sometimes traced to phosphate deficiency[4,8,9,10,11,12,13] though not always explained on this basis [14,15,16,17,18]. Effective phosphates have been postulated such as phosphates present as phosphoric acid,[19] or those in true solution.[20] Davis (*loc. cit.*) discovers a characteristic phosphate status in the clarified juice of a variety (leading to possibilities of organo-phosphates) and concludes that a better criterion is the residual phosphate level or the amount of phosphates eliminated.

The part played by non-sugars under the drastic treatments of the white sugar factory being thus clear, their greater importance in the open pan system need hardly be stressed. Large varietal differences in gur quality are a matter of common experience, marked variation in respect of non-sugars in juices of different varieties having also been observed.[21,22,23] It, therefore, becomes important to evaluate varieties for the open pan industry with regard to the nature and extent of non-sugars in their juices as also to assess the role of these ingredients in determining quality of the product.

In these experiments, eight important cane varieties (in four replications) were examined, the juices being analysed for Pol, reducing sugars, total colloids, gums, pectin, total organic nitrogen, "harmful" nitrogen, ash, SiO_2, $Fe_2O_3+Al_2O_3$, CaO, MgO and P_2O_5. Most of the analytical methods have been referred to in previous communication,[24] "harmful" nitrogen being estimated by the method of Unverdorben and Spielmeyer.[25] Gur was prepared from each juice under rigidly standardised conditions (striking point : 118° C.), which were considered satisfactorily reproducible, as evident from—(*i*) Uniform temperature gradients (measured from 105° C onwards) in all cases, (*ii*) constancy in gur/juice ratios in respect of Pol, reducing sugars and ash for all pans boiled, (*iii*) constancy of the ratio between colorimetric index per 100 Bx. in gur (measured in standard solution) and the same quantity for juice, for a particular variety and juice treatment. A classification of the gur samples (on general features ,Pol, reducing sugars, ash, nett rendements, colour, acidity and insoluble matter) distinctly pointed to Co's 313 and 513 as good gur varieties, Co 453 as poor, the rest being medium.

Analytical data pertaining to the juices revealed striking differences between Co's 313 and 513 on the one hand and Co 453 on the other, the behaviour of the rest being intermediate between the two. Thus, Co 453 juices (poor) on an average, showed higher values for the undermentioned ingredients or ratios over those of Co's 313 and 513 (good), the order of percentage difference being shown against each in brackets:

(*i*) Total colloids (130), (*ii*) Ash (40), (*iii*) Ash in colloids/Total ash (50), (*iv*) Gums (70), (*v*) Pectin (80), (*vi*) Harmful N (60), (*vii*) Harmful N/Total organic N (75), (*viii*) Soluble SiO_2 (145), (*ix*) $Fe_2O_3+Al_2O_3$ (100), (*x*) CaO (80), (*xi*) MgO (50).

In contrast to the above, Co 453 juices exhibited lower values for P_2O_5 content, being of the order of 30 per cent. below those for Co's 313 and 513. The important role of non-sugars in the open pan industry is thus clearly brought out. Further work is in progress.

The work was conducted as part of the Sugarcane Research Scheme in Bihar, being financed jointly by the Government of Bihar and the Indian Central Sugarcane Committee, to whom grateful thanks are due.

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May 25, 1949.

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PRECIS ORITHYA SWINHOEI L. (FAM. NYMPHALIDAE), FEEDING ON *STRIGA* Spp.-THE PHANEROGAMIC PARARSITE OF SUGARCANE AND JOWAR

IN 1946 August, one of us (D.V.M.) noticed a number of butterfly caterpillars feeding on *Striga-Spp.*—a root parasite of sugarcane and jowar in this tract. The caterpillars on rearing emerged into butterflies, provisionally identified as "*Precis Orithya Swinhœi*" L., popularly known as "Blue Pansy". During the same period the caterpillars were noticed on *Striga* in some of the sugarcane plots at Rudroor, and later during winter months, at Bodhan and nearby places.

Striga Spp.—the root parasite of sugarcane is a fairly serious pest in the Nizamsagar tract and during August 1939, Rai Saheb Prof. L. S. S. Kumar of the Bombay Agricultural Department, visited the area on tour and suggested various remedial measures for the eradication of the pest. In his report[1] he alludes of having noticed a butterfly caterpillar feeding on *Striga densioflora*. It is not known whether it is the caterpillar of *Precis Orithya Swinhœi* L. he is referring to.

The butterfly, though observed all the year round, is abundant only during the winter months. The seasonal distribution is as follows (see Table I).

During the months of December 1948 and January (1949), when rearing was done in the laboratory, its life-history was as follows:

Egg period 4-5 days, Larval period 10-15 days and the Pupal period 10-12 days. The meteorological data in the laboratory where rearing was done is given in Table II.

TABLE I

Month	Caterpillars collected during field observations round about Bodhan	Butterflies noticed
October	22	In few numbers
November	120	In large numbers Flitting during midday & copulating
December	112	Do
January	53	In few numbers
February	12	Do. Observed on *Striga* in *Rabi* jowar plots
March	nil	In very few numbers
April	3	In negligible numbers
May-October	Almost nil	In very negligible numbers

TABLE. II

Average meteorological data of the Laboratory where rearing was done

Month	Maximum Temp.	Minimum Temp.	Humidity
December '48 ..	78·3° F.	72·2° F.	65
January '49 ..	78·9° F.	70·9° F.	66

The eggs of the butterfly are laid singly on tender leaves and buds and the caterpillar feeds on them. However the caterpillar is not a voracious feeder. The effectiveness of the butterfly in reducing infestation of *Striga* is being worked out.

Apart from the above a few more insects on *Striga* have been observed. Investigations will be carried as and when opportunity arises.

Thanks are due to Prof. Rai Saheb L. S. S. Kumar and Dr. Md. Qadiruddin Khan for kind help.

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Department of Agriculture,
Bodhan (Deccan), *June* 9, 1949.

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A MORE RAPID PRESUMPTIVE TEST FOR COLIFORM BACTERIA IN WATER

THE findings of Mallimann and Darby[1] were utilized in devising a rapid test for coliform bacteria in water by Sandholzer and Quimby.[2] For this test a medium of the following composition is recommended:

Tryptose	..	20%
Di-potassium hydrogen phosphate	..	4·0%
Potassium dihydrogen phosphate	..	2·0%
Duponol*	..	0·1%
Potassium nitrate (nitrite free)		1·0%

* Obtainable from Ashe Laboratories, London.

As tryptose was not available in India (or even U. K.) a modification of the above medium was necessitated; it was observed that Stearns peptone could effectively replace tryptose and that it is better not to mix sulphonilic acid with alpha naphythylamine after their preparation in the dark bottle as was recommended by the above workers. Results obtained by this method on two hundred samples of raw, settled, filtered and chlorinated water were compared with those recorded by Macconkey's Bile Salt Neutral Red Lactose broth method of water analysis.[3] The results reveal (see table below) that there is no significant difference between them and those by the above authors. It is therefore obvious that peptone can be conveniently used in place of the more expensive tryptose.

TABLE I

The comparison of nitrate reduction test for coliform bacteria with the standard method and with the results obtained by Sandholzer and Quimby.

No. of samples tested*	Nitrite positive confirmed*	Reaction in Duponol-Peptone Medium Tested after: 6 hrs.	8 hrs.	10 hrs.	12 hrs.	14 hrs.	24 hrs.	48 hrs.	No. of samples tested†	Nitrite positive confirmed†
4	4	+	+	+	+	+	+	+	0	0
54	54	–	+	+	+	+	+	+	26	26
27	27	–	–	+	+	+	+	+	13	13
20	20	–	–	–	+	+	+	+	18	12
1	1	–	–	–	–	+	+	+	8	3
26	4	–	–	–	–	–	+	+	7	2
11	1	–	–	–	–	–	–	+	8	1
57	0	–	–	–	–	–	–	–	20	0

* Tested by the present author on MacConkey's Bile Salt Neutral Red Lactose broth as per standard method, and on Duponol Peptone as a test medium.

† Tested by Sandholzer and Quimby on Brilliant Green Lactose Bile-salt broth method as standard method and on Duponol-Tryptose as a test medium.

The author is indebted to the staff and especially to Mr. George Fylinto, B.Sc., of the Public Health Laboratory, Poona, for the co-operation.

Fergusson College, Poona 4, *August* 19, 1949. T. J. BAMAN.

1. Mallimann, W. L., and Darby, C. W., *Am. J Pub. Health*, 1941, **31**, 127. 2. Sandholzer, L. A., and Quimby, F. H., *Jour. of Bact.* 1945, **50**, 105. 3. Ministry of Health No. 71 (1936).

A STUDY IN CONTRAST OF THE EFFECTS OF COCOANUT WATER ON THE GROWTH OF IMMATURE EMBRYOS OF CORN (MAIZE) WHEN APPLIED BEFORE AND AFTER GERMINATION OF THE EMBRYO

IN an exploratory experiment to find out the effect of natural extracts on the growth of a two-week-old corn embryo, it was observed that these extracts exercised some depressing effect upon the germinating embryo; in other words, it took a longer time for the embryo to germinate in the culture medium when in contact with the extract than when it was absent. The natural extracts tried were cocoanut meal extract and young corn ovule extract. A similar depressing effect was observed in the case of cocoanut water (Uttaman,[1] 1949). To examine this phenomenon more critically and, incidentally, to seek an explanation thereof, the following experiment was set up.

Two-week-old corn embryos were used. The treatments consisted of:

1. Cocoanut water applied at the time of placing the embryo in the medium.
2. Cocoanut water applied the next day when the embryo had just started germinating.
3. Control.

Tukey's medium *plus* active growth promoting ingredients used in culturing very young embryos of corn in a previous experiment (Uttaman,[2] 1949) was used for culturing these embryos. Each treatment was replicated three times and growth measurements for shoot and root were made for the same embryo continuously for five days. The results are entered in the table below. The method of application and the quantity applied, of cocoanut water

was the same as in the previous experiment to find out the effect of cocoanut water on the embryo growth.

Embryo placed in the medium on 8-9-1947

Replication	Date of measurement	(1) Cocoanut water applied at the time of placing the embryo in the medium		(2) Cocoanut water applied next day when the embryo had just started germinating		(3) Control	
		Shoot mm.	Root mm.	Shoot mm.	Root mm.	Shoot mm.	Root mm.
1	9-9-47	Not germinated		2·0	0·5	1·2	1·5
	10-9-47	6·5	1·1	12·9	1·2	13·7	16·8
	11-9-47	13·4	1·1	27·2	1·2	29·5	23·1
	12-9-47	24·4	1·1	36·1	3·0	44·8	31·0
	13-9-47	31·9	1·2	40·2	3·0	46·5	36·2
2	9-9-47	Not germinated		2·2	1·0	1·3	1·3
	10-9-47	5·9	3·5	11·5	1·8	14·3	13·3
	11-9-47	5·9	3·5	26·8	3·0	37·3	30·3
	12-9-47	33·3	3·5	38·6	3·0	59·3	37·6
	13-9-47	35·3	3·6	44·4	3·0	69·2	40·4
3	9-9-47	Not germinated		2·5	0·5	1·1	1·0
	10-9-47	Just germinating	Nil	12·5	1·2	13·0	16·5
	11-9-47	3·4	Nil	31·0	1·2	31·9	29·4
	12-9-47	3·4	Nil	44·4	2·4	46·9	35·5
	13-9-47	3·4	Nil	Fungus attack		54·3	44·5

From the above results it will be seen that the embryo in treatment 1 failed to germinate on the second day and that the growth of the embryo is more marked when the cocoanut water is applied after the embryo has germinated than when applied before the germination.

Discussion.—The reason for the differential behaviour in the growth of the embryo in the case where cocoanut water is applied before as compared with after the germination of the embryo might be found in the hypothetical suggestion that by the time the embryo starts to germinate the embryo factors decompose into certain toxic component parts which depress the germinating embryo and that most part of the opportunity to benefit by the embryo factors, is lost to it. That the loss of the embryo factor activity due to heating, chemical treatments, standing, etc., may be due to a release of toxic substances which inhibit the growth of the embryo has been demonstrated in the case of Datura by previous workers (Van Overbeek, 1942; Van Overbeek, Conklin and Blakeslee, 1941).

Agric. Res. Institute, Coimbatore, *July* 15, 1949. P. UTTAMAN.

1. Uttaman, P., "The effect of cocoanut water on the growth of immature embryos of corn (maize," *Curr. Sci.*, July 1949. 2. — "Culturing of pro-embryos of normal diploid corn (maize) aged 3-7 days," *Curr. Sci.*, June 1949. 3. Van Overbeek, J., "Cultivation *in vitro* of small Datura embryos," *Am. Jour. Bot.*, 1942, **29**, 471. 4. Van Overbeek, J., Marie E. Conklin, and A. F. Blakeslee, "Factors in cocoanut milk essential for growth development of very young Datura embryos," *Sci.*, 1941, **94**, 350-51.

ERGOT ON BAMBOO

IN May 1949, several clumps of *Bambusa* sp. near Gudalur (Nilgiris) were found affected by a peculiar disease. From the apices of several shoots whitish to dark brown elongated, curved or twisted sclerotioid bodies up to about an inch in length had formed. These projected out of the sheaths of the topmost leaves. Some of them were covered with a creamy white semisolid mass similar to what appears in the sphacelial stage of *Claviceps*.

Sections of the sclerotioid bodies showed that the core was white made up of a compact mass of hyphal cells. Towards the periphery a dark layer was evident all around the sclerotium. External to this layer the hyphal plexus gave rise to labyrinthine folds and drepressions lined by palisade-like cylindrical conidiophores which abstricted conidia one after another. The conidia were elongated, spindle shaped, hyaline, one celled and measured $7 \times 3\,\mu$ ($4\text{-}10 \times 2\text{-}4$). They germinated when floated on water giving rise to germ tubes mostly laterally.

The hyphæ permeate the young tissues of the stem at the tip of the branch. On coming out of the tissues they formed a whitish basic stroma eccentrically placed between the sheaths and the stem on the side where the sheath opened. Originating from this base was the elongated and often twisted sclerotium which was white in the initial stages but developed a dark greenish brown colour on the outside as it became older. Longitudinal fissures were formed in older sclerotia. The sphacelial stage formed a creamy deposit on the surface.

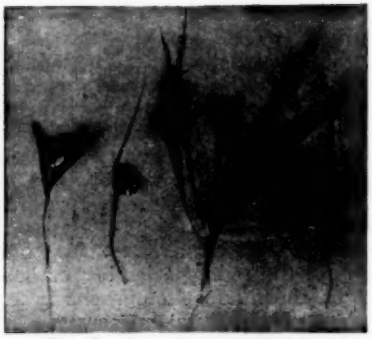

FIG. 1. Sclerotia on the shoots

FIG. 2. Section of sclerotium with sphacelial formation

FIG. 3. Conidia, three germinating (×850)

The characters of the sphacelial stage and the sclerotium lead one to identify the fungus as a species of *Claviceps*. The peculiar odour felt while handling sclerotia of *Claviceps purpurea* Tul. was present to a large extent in fresh sclerotia. When the sclerotia were powdered and assayed traces of alkaloids were found to be present. These suggest that the fungus is a *Claviceps*. This genus of fungus has been so far observed to infect flowers only. In the present instance there was no flower formation and the infection was confined to the apices of the shoots. The sclerotia were washed and placed in moist and in petri dishes for ten days at 5° C., and again at laboratory temperature for over two weeks. But there was no evidence of germination. Tempere (1933) has reocrded infection of flowers of *Phyllostachys puberula* (*nigra*) by *Claviceps purpurea* from France. But the fungus under study is not *Claviceps purpurea* as is evident from the nature of the conidia. This is the first record of an ergot infecting vegetative shoots of bamboo from India.

T. S. RAMAKRISHNAN.
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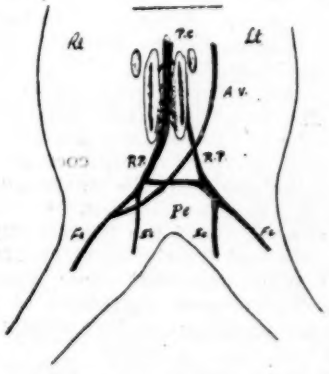
Mycology Section,
Agri. Res. Institute,
Coimbatore, *July* 19, 1949.

1. Tempere, G., *Biol. Abstr.*, 1933, **10**, 1875 (original not seen).

A PECULIAR CASE OF VENOUS ABNORMALITY IN THE COMMON INDIAN FROG *RANA TIGRINA* (DAUD)

THE right renal portal instead of entering the substance of the right kidney takes a downward bend and joins with the post-caval. Apart from this, the pelvic given off by the right femoral is continued as the abdominal in the absence of its fellow from the opposite side.



On the left side, the femoral and the sciatic unite to form the renal portal which after running for a short distance gives off a branch that passess transversely to join the left renal portal. The left side is also

conspicuous by the total absence of the pelvic.

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Bhavan's College, D. VAIDYANATHAN.
Andheri. Bombay, *July* 22, 1949.

THE OCCURRENCE OF STARCH AND ITS IMPORTANCE AS A SPECIFIC CHARACTER IN *SACCHARUM*

DURING the course of the study on sett and shoot-root formation last season, it was noticed that sett-roots were formed late in the Burma form of *S. spontaneum* while in the variety Katha belonging to *S. Barberi* the sett-root formation was both early and profuse. It had been shown by Carlson[2] that shoots of roses grew much more rapidly and developed a more vigorous root system if the nodes of the cuttings from which they grew showed starch accumulation. Sections were therefore cut both in the case of Katha and Burma *spontaneum*; there was more starch accumulation in the stem of Katha than in Burma *spontaneum*.

Went (quoted by Onslow[4]) observed that much starch is present at first but it gradually disappears forming hexose. After growth ceases, the hexose is diminished and sucrose accumulates. Alfaro[1] and later Haddon[3] noticed that in cane grown in acid soils there was accumulation of starch while that grown on alkali soils showed no starch. This aspect of the question was later studied by Weller[5] who came to the conclusion that two distinct types of starch accumulations occur in the cane plant. The first type occurs only above the nodes in the first two or three layers of parenchyma cells surrounding the vascular bundles. He observed this in H. 109 grown in both acid and alkaline soils. The second type occurs in all of the parenchyma cells and he observed it only in Natal Uba. He further pointed out that these accumulations of starch were suggestive of causes of varietal variation in the rooting habit of cane.

It occurred to the present authors that why Went did not notice starch in the fully grown internodes was may be because he was dealing with only *S. officinarum* varieties and why Weller noticed starch in Uba was that this might be characteristic of *S. sinense*. A few varieties belonging to the species of *S. officinarum*, *S. spontaneum*, *S. Barberi* and *S. sinense* were examined and it was found that there was practically no starch in *S. officinarum* varieties. On the other hand there were relatively large quantities of starch in *S. Barberi* but only traces to small quantities in *S. spontaneum* while *S. sinense* came in between *S. Barberi* and *S. spontaneum* with regard to the accumulation of starch. The presence or otherwise of starch as seen in transverse sections of the four species of *Saccharum* is shown in the micro-photographs in Plate I. These sections were taken from the bottom-most internode.

PLATE I

Accumulations of Starch in the stem of *Saccharum* species

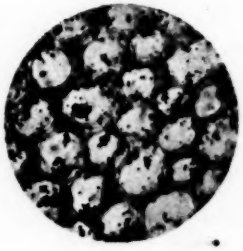


FIG. 1
Katha (*S. Barberi*)

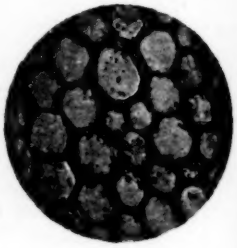


FIG. 2
Uba (*S. sinense*)

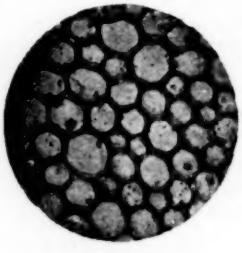


FIG. 3
Coimbatore (*S. spontaneum*)

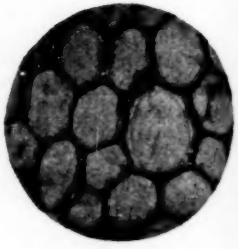


FIG. 4
Vellai (*S. officinarum*)

×150

The above observations were then extended to the other varieties in the Collection. Seventy-eight varieties of *S. officinarum* have been studied and in all of them there has been no accumulation of starch except in ten varieties in which traces or very small quantities of starch have been

observed in the top portion of the stem. Eightyfive varieties belonging to *S. Barberi* have been studied and in almost all of them a relatively large accumulation of starch has been noticed both at the base of the stem and at the top portion. Examination of 25 varieties belonging to *S. sinense* showed that in most of them the quantity is not so much as in *S. Barberi* but a fair quantity is present in all excepting 3 or 4 in which only traces have been met with. Twenty-six varieties belonging to *S. spontaneum* were studied and only small quantities of starch were noticed, though in 8 or 9 types a fair accumulation but lesser than in *S. sinense* and much less than in *S. Barberi* was noticed. Preliminary observations were also made on other genera and it was noticed that there was no starch accumulation in *Sclerostachya* and *Narenga*, while starch has been noticed in Guinea grass (*Panicum maxicum*), Napier grass (*Pennisetum purpureum*) and *Sorghum*. Eight types of *Erianthus* have been studied and fair to large quantities of starch accumulation were noticed.

The observations have been restricted to the fully formed portions of the stem. Sections were taken at two points (1) at the bottommost joint above the ground and (2) the joint at the top next above the dead leaf joint, *i.e.*, the oldest functioning green leaf. These observations were made on almost fully matured crop of about 11 months growth.

These studies are being continued. The indication at present is that the presence of starch in the fully formed internodes is a definite specific character for certain species of *Saccharum*. It is hoped to extend the studies to the numerous inter-specific and inter-generic hybrids at the Station to ascertain how this character is modified in these.

Sugarcane Breed. Station,
Coimbatore, N. L. DUTT.
July 26, 1949. R. NARASIMHAN.

1. Alfaro, *Ann. Conf. Cuban Sugar Tech.*, 1928. 2. Carlson, M. C., *Bot. Gaz.*, 1929, **87**, 64. 3. Haddon, E., *South African Sugar Journal* **10**, 629. 4. Onslow, M. W., "The Principles of Plant Biochemistry," 1931, 25. 5. Weller, D. M., *Hawaiian Planters Record*, 1929, **3**, 294.

CHROMOSOME NUMBERS IN SOME ANGIOSPERMOUS PLANTS

ACCORDING to the information of the authors, the chromosome numbers reported here are new.

*The morphological features of *Justicia adhatoda* Linn. is so different from other species that it was kept under a separate genus as *Adhatoda vasica* Nees. Its haploid chromosome number 17 as compared to 14 of other species confirms this separation.

MELIACEÆ		
Melia azadirachta Linn.	$2n=28$	Pathak & Singh
POLYGONACEÆ		
Rumex dentatus Linn.	$n=20$	,,
APOCYANACEÆ		
Allamanda grandiflora Hook.	$n=9$	Pathak & Tiwari
Tabernæmontana coronaria Willd.	$n=11$	,,
Thevetia nerifolia Juss.	$n=9$	,,
SIMURACEÆ		
Ailanthus excelsa Roxb.	$n=31$	Pathak & Srivastava
Balanites ægyptiaca Delice	$n=9$	,,
STERCULIACEÆ		
Pterospermum acerifolium Willd	$n=19$	,,
Sterculia colorata Roxb.	$n=20$	,,
ACANTHACEÆ		
**Justicia adhatoda* Linn.	$n=17$	Pathak & Pande
Eranthemum variegata Linn.	$n=21$	,,
Daedalacanthus nervosus T. Anders	$n=21$	,,
BIGNONIACEÆ		
Tabebuia pentaphylla Gomez	$n=20$	,,
Jacaranda mimosifolia D. Don.	$n=33$	,,
RUTACEÆ		
Murraya exotica Linn.	$n=9$	,,
EBENACEÆ		
Diospyros embryopteris Pers.	$n=15$	,,

G. N. PATHAK.
B. SINGH.
Govt. Agri. College, K. M. TIWARI.
Kanpur, A. N. SRIVASTAVA.
January 3, 1949. K. K. PANDE.

CULTURAL WORDS OF CHINESE ORIGIN: MONSOON

THE following information has been summarized from Yule[1] and Burnell, almost in their own words: "Monsoon is the name given to the periodical winds of the Indian seas—The original word is the Arabic Mausim, season, which the Portuguese corrupted

into Moncao and English into Monsoon. It had the sense of periodical winds among Arab pilots from whom the Portuguese adopted the word. The Turkish Admiral, Sidi Ali, writes that Mausim as a word is used for anything that comes round but once a year like the festivals. In Lebanon Mausim is the season of working with the silk, in Yemen the season of navigation." What we do realise, even today, is that monsoon represents rain more than wind and unlike wind or a rainy shower which is capricious in its nature, monsoon comes so regularly every year that the time of its visit can be predicted even beforehand. This singles out monsoon as a special phenomenon.

It is self-evident that a knowledge of the monsoon must have greatly helped navigators of the Indian Ocean. R. Sewell[2] says that the regularity of monsoon in the Indian Ocean was discovered in B.C. 47 when Alexandria was taken by Julius Cæsar. It was only after this discovery that ships began to sail direct to Malabar. But this can only refer to Indo-Roman trade and it is more probable that the Romans then acquired this knowledge directly from foreign pilots rather than by discovering the phenomenon for the first time. Here we may inquire about the maritime trade between India and the Far East and the knowledge of monsoon possessed by Eastern pilots that brought ships to India?

J. Kennedy[3] writes that "from the history of Chinese coinage it can be shown that an active sea-trade sprang up about 700 B.C. between Babylon and the East and that India had an active share in it". If the Chinese came to Babylon and sailed through the Indian Ocean they must have had precise knowledge of the monsoon and must have planned their voyages accordingly. What the Romans came to know second hand at about 50 B.C. the Chinese must have had first hand about 700 B.C.? This date strikes as rather early. According to Pelliot, as cited by Laufer, in his *Sino Iranica*, p. 543 "the earliest date we may assume for any navigation from the coasts of Indo-China into the Indian Ocean is the second century B.C.". Even this suffices for our purpose for the question can be raised, how did the Arabs, rather late in the history of navigation, happen to be the first to designate the monsoon of India such that their name alone has become almost universal? If the Chinese sailed in the Indian Ocean during the second century B.C. what was their name for the monsoon. Above all it is natural to expect that the rainy season of India should have had a Sanskrit term. But this seems secondary to those who, living in India, have expressed a far more precise knowledge of the phenomenon through their "Mrig Nakshtra" which actually gives the date, when the rainy season begins. In this light only the incoming foreign sailors, uninitiated in such knowledge and deeply impressed by the regularity with which the monsoon begins, have given it a designation connoting *the rainy season*, for nothing like it exists elsewhere.

Apart from all secondary meanings attributed to it we must admit that monsoon signifies *the rainy season*. It comes regularly, to use Sidi Ali's terminology, like an annual festival. On the contrary, Mausim, as an Arabic word, merely connotes a season and not any special rainy season. Moreover the word Mausim is derived from the root Vasm, given by Platts,[4] on p. 1090, as meaning "to describe"; "to excel in beauty". How a word to "excel in beauty" can give raise to a derivative signifying the rainy season special to the Indian Ocean can be appreciated only by philologists who have divorced all love for physical geography. I have shown before how such a far fetched etymology can be replaced by a common-sense explanation once we look upon it as a loan word. Monsoon in Chinese at once represents the phenomenon expected of the word.

Giles,[5] gives Character No. 7693, as Mao, meaning a period. It does not express a duration as in the phrase "period of a year". Instead it is used in pharases like "the fixed dates at which the muster is made" and "the morning bell in a monastery", where the beginning is precisely indicated. Character No. 275 is Chan, translated as "a soaking rain". A phrase using this word is translated as "wet to the skin" which is expected alone of a soaking rain. These two words give rise to the term Mao-Chan, a period of heavy rains, or better heavy rains, which come annually and begin at the expected time for which Mao would be the right word. B. Karlgren,[6] in item No. 602, translates the Cantonese pronunciation of

the word Mao as Mau, and in item No. 1163 Chan as T'sin. Thus Mao-Chan in Cantonese becomes Mau-Tsim which the Arabs could not have transliterated better into popular tongue than as Mau-Sim. Like typhoon, monsoon represents features of its own. As opposed to the capricious nature of rain and wind, monsoon is as regular as an annual festival. This regularity makes it conspicuous as a type. Typhoon, which is a dreadful wind, is used in terms like Tufan-Mail, meaning a very fast mail train, simply because the happier side of its nature represents its speed. Likewise Mau-Sim, the period of heavy rains, is extended to express a season which begins with as much respect to the time of the year as the monsoon of the Indian Ocean does, being then a compliment to such a season. While the secondary meanings of the term Mau-Sim have varied, the primary one, as a period of heavy rains, has been fully retained in the word monsoon even to this day.

SUMMARY

Monsoon, the English word, comes from the Portuguese, Moncao, which is derived from the Arabic, Mausim. This word has the root, Vasm, meaning nothing better than "to excell in beauty". Yet Monsoon is considered to be a derivative from this Arabic root. On the contrary, the Chinese term Mao-Chan, means a period of heavy rains. This term in Cantonese is pronounced Mau-Tsim which was transliterated into spoken Arabic as Mau-Sim. The Arab pilots learnt of Mausim from Chinese sailors. As a Chinese term alone Monsoon becomes a genuine connotative word.

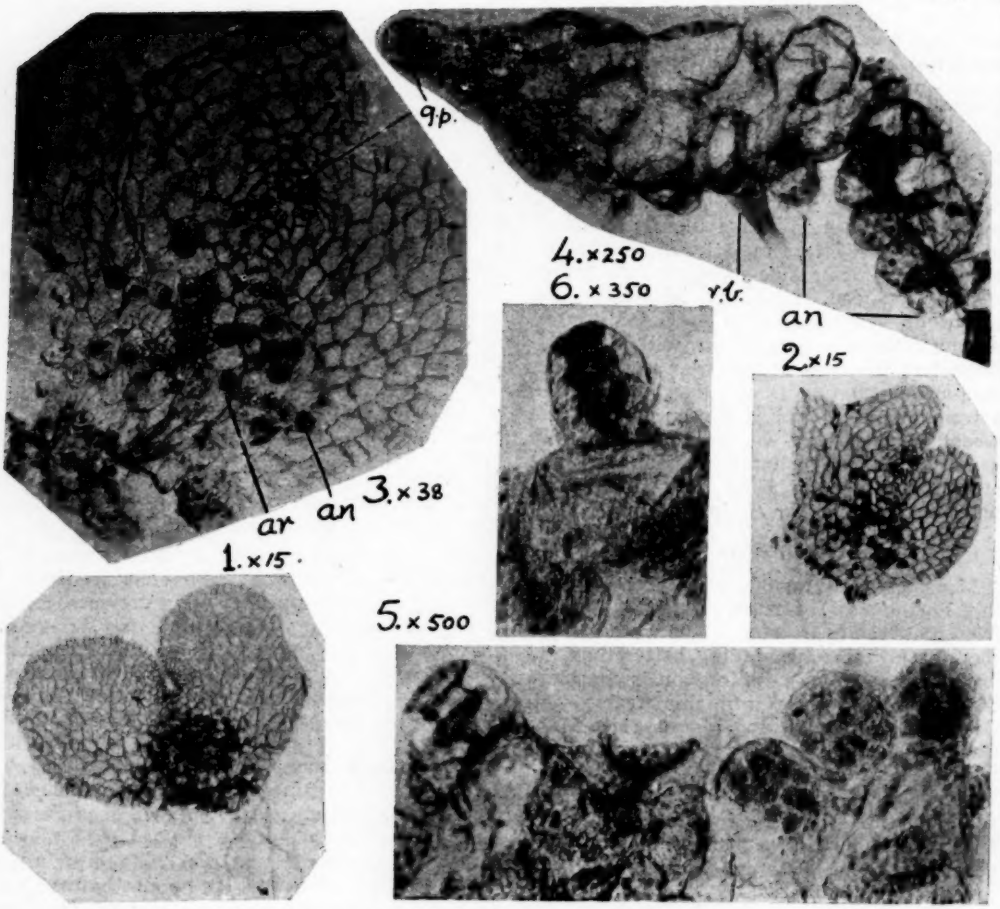
Ciplas, S. MAHDIHASSAN.
Bombay,
August 15, 1949.

1. Yule and Burnell, *Hobson-Jobson*, 1903, 577. 2. Sewell, R., "Roman Coins in India, *J. R. A. S.*, 1904, 591. 3. Kennedy, J., "Early Commerce of Babylon with India," *J. R. A. S.*, 1898, 241. 4. Platts, J. T., *A Dictionary of Urdu, Classical Hindi and English*, 1911. 5. Giles, H. A., *A Chinese-English Dictionary*, 1892. 6. Karlrgen, B., *Analytic Dictionary of Chinese and Sino-Japanese*, probably 1923.

THE PROTHALLUS OF *HEMIONITIS ARIFOLIA* Sm.

THIS xerophytic fern belonging to the Polypodiaceæ grows abundantly in South India, at slight elevations and generally between rock crevices and damp brick walls, etc. A brief account of the sporophyte and its anatomy has already been published (Rao, 1946). The prothallus of this fern was however not easily found. Attempts to artificially germinate the spores did not succeed as the spores found on fertile leaves were not sufficiently ripe enough. This year however, Sri. K. Subramanyam, Central College, Bangalore, kept a careful watch for these prothalli and succeeded in securing a few which are now being described.

The prothalli were found growing gregariously amongst moss protenema on moist substrata in the crevices of rocks. A few young plants obviously derived from old prothalli were also found along with the gametophytes, often attached to them. The adult prothalli are monoecious, comparatively small in size, 3-4 mm. broad, dark green in colour and typically cordate and bilobed (Photos 1-3). Often the prothallus presents a trilobed appearance (Photo 2) probably a modification of the fundamentally bilobed condition due to enviromental factors. The growing point is only one even if the prothallus is trilobed, and is situated in the median notch as usual (Photos 1-4). Both the sex organs are equally well developed and occur together (Photo 5) on a small cushion on the underside only, so far as has been observed. The antheridia are round, numerous and appear to be as in other members of the Polypodiaceæ (Photo 4). The archegonia are short and show just three tiers of cells (Photos 5 & 6). There appears to be only one neck canal cell as in the Polypodiaceæ. So far as could be made out no mycorrhiza is associated with the prothallus. To the best



Hemionitis arifolia Sm. Explanation of photographs

1. Bilobed prothallus seen from the underside showing median notch, sex organs and rhizoids. 2 Trilobed prothallus seen from the underside showing rhizoids, sex organs, and a single growing point located in the median notch. 3. The lower surface of the specimen seen in Photo 2 photographed on a large scale to show the growing point (*g.p.*), antheridia (*an*) and archegonia (*ar*). 4. A free hand section of the prothallus passing in the median plane. The growing point (*g.p.*) is seen on the left; the rhizoidal bases (*r.h.*) and a row of antheridia (*an*) can be seen on the lower side. 5. Part of another freehand section of a prothallus showing three antheridia on the right, each showing sperm mother cells, and probably a tangentially cut archegonium on the left. 6. An archegonium showing three tiers of cells.

of my knowledge the prothallus of this species of *Hemionitis* has not been described so far. A detailed study of the prothalli will be published elsewhere.

Department of Botany,
Lucknow University,
July 15, 1949.

A. R. Rao.

Rao, A. R., *Curr. Sci.*, 1946, **15**, 141–42.

REVIEWS

Advances in Protein Chemistry, Vol. III. Edited by M. L. Anson and John T. Edsall, (Academic Press Inc., New York, N.Y. 1947. Pp. xii+524. Price $7·50.

This third volume in the series will be eagerly welcomed by all investigators interested in proteins. Of the 11 contributions, nine of them originate from American Laboratories; this bears eloquent testimony to the rapidly growing schools of protein chemistry which are establishing themselves in the States.

Braunstein who discovered the phenomenon of transamination reviews the subject of transamination in relation to protein metabolism and discusses the integrative functions of the dicarboxylic acids. The main object of the article has been to "summarise the present knowledge of this metabolic process and to sift well-established facts from erroneous or doubtful conclusion due to imperfect experimental technique and to premature generalisations". This is an opportune contribution of fundamental interest.

The preparation and the physical magnetic and immunological properties of the coloured iron-containing ferritin and colourless and iron-free apoferritin are described by Michælis in the second review. Adsorption analysis of mixtures of amino acids is the subject of a stimulating review by Tiselius who has pioneered the development of this useful and highly promising analytical tool. Henry B. Bull has presented a useful summary of the papers on protein monolayers; this is followed by a review on Films of protein in biological processes by Alexandre Rothen. The chemical determination of proteins is the subject of a review by Paul L. Kirk.

Roger M. Herriot has presented a comprehensive and critical review on the reactions of native proteins with chemical reagents, a field of study in which those interested in the elucidation of the structure of proteins in relation to their biological activity would be particularly interested. The subject has other applications *e.g.*, the modification of the undesirable properties of certain proteins so that they may be used medicinally and the conjugation of carcinogens to proteins for the purpose of producing antisera. Nutrition chemists will be deeply interested in the review on the amino acid requirements of man by Anthony A. Albanese. A useful summary of our knowledge regarding the symptoms of amino acid deficiencies in man, has been included. Closely allied to this is a review by Robert Elman on the use of protein and protein hydrolysates for intravenous alimentation. Attention is drawn to the fact that large peptide molecules could be more rapidly and more efficiently utilised by certain types of tissues than small peptides and single amino acids. This raises the question of the degree of digestion of proteins which would secure for the hydrolysate the highest possible nutritive potential.

The last two reviews relate to (1) the preparation and criteria of purity of amino acids by Max S. Dunn and Louis B. Rockland and (2) the plasma proteins and their fractionation by John T. Edsall. The newer methods of fraction described in the review will be of inestimable value to all protein chemists.

Proteins dominate every field of Biochemistry and the ADVANCES in this fundamentally important branch will appeal to a wide circle of investigators covering both biophysics and biological chemistry including medicine.

Fundamental Processes of Dye Chemistry. By H. E. Fierz-David and Louis Blangey. Translated by Paul W. Vittum from the 5th edition of *Grundlegende Operation der Farbenchemie* (Springer-Verlag, 1943; Interscience Publishers, New York), 1949 Pp. 479. Price 9.50 dollars.

Grundlegende Operationen der Farbenchemie, first published in 1922 and revised in 1938 and 1943, has been the standard book on the subject. The Fifth Austrian edition of this useful book has now become available in English. The book consists of six parts: intermediates, dyes, technical details, analytical section, analysis of commercial dyes, and determination of light fastness.

The first part includes a brief survey of some of the unit processes of organic synthesis; these are described as "operations" although it is more usual to restrict the latter term to the unit operations of chemical engineering such as filtration and evaporation. An excellent account is given of the isolation and purification of dyestuff intermediates, together with tests for the purity of the products. The discussion of orientation rules which follows is one of the unsatisfactory features of the book. This might well have been omitted from a prac-

tical manual, but if its inclusion was considered necessary, there must have been some indication of the theory of aromatic substitution. One of the few important carbazole intermediates is 2-hydroxycarbazole, and in the account of orientation in the carbazole series the route to this substance through carbazole-2 : 3 : 6 : 8-tetrasulphonic acid is not mentioned. There is also no reference to the synthesis of carbazole derivatives of definite orientation by the dehydrogenation of tetrahydrocarbazoles, which are readily obtainable from the appropriate cyclohexanonephenylhydrazones. It is stated that the nitration of toluene gives a small percentage of *m*-nitrotoluene, but not that this is isolated commercially and used for the manufacture of *m*-toluidine and *m*-cresol. The "theoretical" section on diazonium coupling gives no indication at all of the mechanism of the reaction; a brief explanation would have rendered the behaviour of various diazonium salts and coupling components easier to follow. The authors prefer to speak of diazo compounds, rather than diazonium salts. Dealing with 1-amino-2-naphthol-4-sulphonic acid, it is not mentioned that the product of diazotization is a diazo-oxide. The function of pyridine in coupling is much more complicated than that of a solvent or an acid fixing agent, and it needs in fact to be investigated.

The most valuable part of the book is the description of detailed procedures for the laboratory preparation of dyestuff intermediates of the benzene, naphthalene and anthraquinone series. The preparation of each intermediate is followed by "technical observations", in which the manufacturing method, precautions to be taken, type of reaction vessels used and the applicability of the process to other intermediates are outlined. Diagrams of laboratory set-ups are supplied for many preparations.

Part II, which follows the same pattern as the section on intermediates, describes preparative methods for a few dyes of the azo, diphenylmethane, triphenylmethane, azine, thiazine, anthraquinone, indigoid, sulphur and phthalocyanine series. In the "technical observations", dyeing and fastness properties are briefly discussed. Although the authors have clearly stated that the book is not an encyclopedia but a laboratory manual for the beginner in dyestuff chemistry, the omission of some intermediates and dyes of great importance is to be regretted. Examples are benzanthrone, stabilized diazonium salts, mixtures of the latter with azoic coupling components used as printing compositions (Rapid Fast and Rapidogen types), preformed metal-dye complexes of the Neolan type, and dyes for cellulose actetate. Naphtol AS is not mentioned, but curiously enough Naphtol AS-ITR is. While vat dyes are in many ways the most important group among the synthetic colouring matters only two, Indanthrene Blue RSN and Indanthrene Yellow GK, are included; the second has now become nearly obsolete, and its preparation, which is merely the benzoylation of an amine, is simple. Dyes such as Caledon Jade Green and Indanthrene Khaki GG are of much greater interest, both chemically and commercially. At least one example of a solubilized vat dye (Indigosol and Soledon type) should have found a place. The statement that "the Bohn-Schmidt reaction is of little importance technically" (p. 60) is surprising. 5-Aminosalicylic acid is erroneously mentioned as *p*-amino-salicylic acid (p. 156). The wealth of extremely valuable information on the German dyestuff industry which has now become available in B.I.O.S. and F.I.A.T. reports is dismissed airily with the remark that the methods described in the book before these reports appeared are largely similar to I.G. processes, and where they are different the authors' procedures are preferable for laboratory purposes. To quote only one example among many, the B.I.O.S. process for 1: 4-diaminoanthraquinone from quinizarin is much to be preferred to the method described in the book (p. 230).

Parts IV (Analytical Section) and V (Analysis of Commercial Dyes) give the impression of being put together hastily from the previous edition with little attempt to bring the material up to date. Chromatography gets a bare mention, and there is no reference to such methods as the titration of acid dyes with basic dyes and the purification of azo dyes by means of potassium acetate or di-*o*-tolylguanidine. Part VI gives an account (by Dr. H. Ris) of light fastness; other equally important fastness properties are not mentioned. References are restricted almost entirely to Fierz-David's books and papers and to German patents. *Organic Syntheses* and some recent manuals of practical organic chemistry contain a considerable number of dyestuff intermediates, and references to them would have been useful to students for whom this book is intended. The printing is excellent and the diagrams are clearer and better drawn than in the Austrian edition. However, several errors in printing have been noticed—*e.g.*, 3 instead of 8 in p. viii; ref. 9 in p. 410; the fourth line from the bot-

tom in p. 334; NH missing from the formula for Helindone Brown in p. 460; and the peculiarly bent bond in the structure for Indanthrene Olive R. The constitution assigned to Helindone Brown is that of Indanthrene Yellow 3R.

K. V.

Principles of Electricity and Electromagnetism. By G. P. Harnwell. (McGraw-Hill Book Company, Inc.), 1949. (New Second Edition). Pp. xvi+670. Price $ 6.

The first edition of the book under review was published over a decade ago in the International Series in Pure and Applied Physics. This earlier book has now been thoroughly revised in the light of the many recent important contributions to electrical theory and practice. The present new edition should make a special appeal to the advanced students of electricity, who will recognise in it an admirable text-book.

The book presupposes that the student is already quite familiar with the groundwork of physics and more especially of electricity and magnetism. The fundamental and classical electric phenomena are properly stressed, and the study of electrical power and communication engineering as well as of electrical devices and measuring techniques has also received its due emphasis. As the recent developments in electronics and the atomic and nuclear physics profoundly influence the physical basis of electrical theory, adequate stress has been laid on these and allied phenomena. Students, on whose part a greater familiarity with atomic physics is assumed, are initiated into the study of the physics of the conductivity of solids, the magnetic behaviour of atoms and nuclei and high energy ion-accelerators.

After presenting the fundamental principles of electrostatics in the first two chapters, the consideration of the physical characteristics of dielectrics and conductors is taken up in the third. The fourth chapter deals with direct current circuits and is followed by a chapter on non-ohmic circuit elements and alternating currents. Developments in the theory and use of thyrite and thermistors have justified the long discussion on non-ohmic elements. Though it must be admitted that the consideration of alternating current springs up rather earlier than usual, it seems to arise naturally out of the greater importance of the non-linear elements in connection with alternating rather than direct currents and more especially in the field of communication engineering. After a consideration of the chemical, thermo-electric and photoelectric effects, Chapter VII gives a complete treatment of the thermionic vacuum tubes and the cathode-ray oscillograph. The chapter on electrical conduction in gases is well developed and ends with a discussion on counters. The belated chapter on electromagnetic effects of steady currents takes up, in addition to the classical problems, the consideration of the magnetic resonance accelerators, mass spectrometers, magnetrons and such other appliances. Similarly the tenth chapter on electromagnetic induction gives the theory of the betatron and discusses the magnetic characteristics of atomic systems leading on to a technique originated by Stern and Gerlach for measurement of atomic and nuclear magnetic moments. The discussion of the magnetic properties of matter in Chapter XI leads on to the description and the theory of electromagnetic machinery. Chapters XIII to XVI are devoted to simple L-R-C circuits, coupled circuits, vacuum-tube circuits and propagation of electromagnetic radiation. These last chapters outline the fundamentals of radio engineering in theory and practice, and the presentation of the subject is both concise and clear.

The mathematical treatment throughout the book is vectorial and the necessary background of the general vector theory is developed in the Mathematical Appendix, which includes also a brief mention of the methods of Fourier Analysis and Differential Equations. A special feature of the book is the provision of numerous problems at the end of each chapter. These problems, which on the aggregate number more than four hundred, are designed to help the student to gain a thorough grasp of the subject.

The happy mingling of the classical and modern outlook in electricity set forth in this book renders it a welcome up-to-date text-book for the Honours and the post-graduate students, who have not at present too many capable text-books on the subject of electricity and electromagnetism.

L. S.

Introduction to Physics. By Harley Howe. Second Edition. (Published by the McGraw Hill Book Company), 1948. Pages 600. Price $ 4·5.

In the preface to the book the author says that originally the text was prepared for the author's large classes of non-technical and pre-medical students, students of agriculture and of liberal arts. It may be said that the author has been successful in this task. A lot of at-

tention has been devoted to the selection of topics that have to be studied by College students (not merely those who specialise in Physics) in these days when Physics has become very important both in peace and in war. Incidentally, the book may be recommended for use by students in India who take up the courses mentioned above.

The book, intended to serve the above purpose, uses no mathematics beyond elementary algebra and plane geometry; however, students desirous of making a further study of the subject can find in it a solid base on which they can build. The book contains a number of examples and a good many illustrations carefully chosen.

The intention of the author is to help the student to develop a scientific approach to experience rather than present him merely with an account of facts. The Introduction makes this clear. Attempt has been made to emphasize that the subject is intimately related to experience. This is very welcome as in these days when the numerous specialised treatises that appear make it hard even for a "physicist" to realize that the most abstract mathematical theories found in Physics are forced on us by experience. Further the forty-five chapters of the book should tell one story and not forty-five, says the author. This is a point to be clearly grasped by many who are expositors of the subject. The book shows how attempts can be made with success even in introductory books on the subject.

D. S. SUBBARAMAIYA.

Cosmic Ray Physics. By D. J. X. Montgomery. (Published by the Princeton University Press, Princeton, New Jersey. Pp. viii+370. Price $5. Agents in India—Oxford University Press). Price Rs. 17-8.

This book is very largely descriptive and is written to suit the needs of the experimenter. It is based largely on the notes of the lectures of Professor M. Schein of the University of Chicago. The purpose of this book is to enable a person to gain a knowledge of this specialised field expeditiously so as to obtain an overall view of the subject. There are copious references which, according to the author are representative and not exhaustive.

The book commences with an introduction to the present status of cosmic ray investigation. An attempt is then made to explain the principles underlying the operation of cosmic ray apparatus and this is followed by a description of the experimental methods in cosmic rays. Subsequently, there are chapters on the intensity of cosmic rays, the hard component, the soft component and the heavy particles in cosmic radiation. The exposition is throughout lucid and the book gives a very readable account of this field of knowledge. Unfortunately, the author does not attempt to go into details. This limits the use of the book to our undergraduate students of experimental physics. Even a student of experimental physics requires a knowledge of the circuits employed in cosmic ray work and this information is lacking.

The reviewer would congratulate any person who can really attempt to write a good book on this subject in our present state of knowledge and technique. Under the circumstances, the following few remarks may be offered without in anyway undermining the utility of the book for general reading. The choice of the material has been a little arbitrary. Some of the criteria developed are not quite correct. To define the hard component and to define it as something which can go through 10 cm of lead is not very desirable.

The appendices are very useful. The Störmer theory, the definition of intensities, the results of the statistical theory of showers, pressure-altitude tables, curves connecting the momentum with energy loss and range in different materials etc., are all very useful. The printing and get-up of the book are excellent. There are a large number of figures and they are carefully chosen and well drawn. The photographs are very well reproduced.

The book can be most heartly recommended as a very useful addition to our college libraries.

S. V. CHANDRASHEKHAR AIYA.

A Study on Mine Surveying. By Sri. S. K. Dhar. (Chotanagpur Industries Ltd., Dhanbad), 1949. Pp. 130. Price Rs. 8.

The book under review deals in a precise manner with a large number of topics from calculation of areas and volumes to the subsidence in mines. A noteworthy feature of the book is that the author has worked out in detail a number of illustrative and very instructive problems. Under each chapter the author has enumerated a number of alternative methods and formulæ that could be employed to solve a particular problem.

Another salient feature of the book is the inclusion of just the amount of theory to enable the students to follow intelligently the several problems worked out in detail. But the theory given under some chapters such as "Tacheometry", "Contouring" is too brief to

enable a student to follow these chapters fully. The usefulness of the book can be enhanced by including topics such as description of the surveying instruments such as levels theodolites, tacheometers, and their temporary and permanent adjustments.

The author may also add, with advantage to the mining students, such topics as continuation of Survey lines, Transference of levels to the underground from the surface, alignment of centre lines of shafts and similar specific applications.

The inclusion of chapters on "Checking Calculations", "Logarithm tables" have enhanced the usefulness of the book though the subject matter has been dealt with rather too briefly.

The book has been got up neatly, and I have no hesitation in saying that it serves admirably the needs of students taking various examinations in mine surveying as well as of young people just entering the profession.

The book will also be a good addition to a technical library where a concise book setting forth the fundamental ideas in mine surveying is needed.

S. R. PRASAD.

Conditioned Reflexes and Neuron Organisation. By Jerzy Konorski, Head of the Department of Neurophysiology in Nencki Institute of Experimental Biology and Professor in the Universityof Lodz. Translated from the Polish MS. under the author's supervision by Stephen Garry. Cambridge Biological studies. Printed at the University Press, Cambridge,) 1948. Pp. xiv+267. Price 18 *sh.*

The physiology of the nervous system has developed along two lines, one by the Sherringtonian and the other by the Pavlovian school. Sherrington has put forward a certain general conception of the functioning of the central nervous system. Broadly speaking, this conception consists in basing the functioning of the central nervous system on its neuron organisation, in laying down that the nervous system acts as a single integrated whole. He carried out an analysis of the interaction of reflexes, indicating the manner in which they participate in the coordination of the organism's activity. The problems of integrative action continued to be studied in many laboratories, but gradually problems in this field have been exhausted and advances have made comparatively less progress from the position which was reached in Sherrington's first monograph. This is chiefly due to the fact that investigations on this subject did not include the main integrating organ, the cereoral cortex.

An extensive investigation of the cerebral activity was undertaken by Pavlov with the aid of the method of conditioned reflexes which he created and which constituted a separate and independent line of enquiry. These two schools of thought however, have not met on common ground, so that, whereas the Sherringtonian concept has spread all over the world and is now studied in many scientific centres and schools, and its achievements have become a generally recognized acquisition of physiological knowledge, the other has so far hardly passed outside the bounds of the school which created it, and remains isolated from the other department of physiology, though it is closely related to it.

In this book, the author has therefore undertaken to extend Sherrington's conception of the functioning of the nervous system to the field of higher nervous activity, on the basis of the experimental material collected by the Pavlov school, as he considers the Sherringtonian conception built upon the basis of investigation of lower nervous activity superior to that created by Pavlov to explain cortical phenonemona. In this he has taken the right step. The facts collected by the Pavlovian school have been systematized and explained on the basis of the conception and data of neurophysiology. The system which can thus be developed, being a logical complement of the system of physiology of lower nervous activity will make it possible to lead the science of conditioned reflexes out of the dead end in which it is at present and thus lead to further development in both the fields. Such a combination was urgently needed, and the author has done a great service to neurophysiology and is to be congratulated on the successful way in which he has accomplished the task.

INDERJIT SINGH .

An Introduction to Comparative Biochemistry. By Ernest Baldwin. (Macmillan & Co., Ltd., London), 1948. Pp. xvi+164. Price 7 *sh.* 6 *d.*

This book does not need any introduction to students of biochemistry. Its popularity and excellence can be gauged from the circumstance that it has gone through three editions in a decade.

Students taking up the study of a science, before they are flooded with detail, should be helped to survey its aims and scope widely, i.e., they must have an integrated view of the science. To this end, as Prof. Hopkins points out, "the book contributes in admirable fashion"; moreover, "from the highly diffuse literature

of comparative biochemistry, Dr. Baldwin has selected for his lucid exposition with skill and judgment".

The two-fold aim of the author, to provide an elementary text-book for students of biochemistry and to provide a starting point for those, who, for any reason, might feel attracted to this subject, has been fully realised. He has, to quote Prof. Hopkin's words "dealt with its different aspects in nice proportion. He has illustrated very adequately in relatively few pages, many of the main lines of progress, leaving in the mind of the reader no doubt concerning their significance. Above all, he has, I feel, displayed his own interest in the subject, an interest intense enough to be infectious".

The whole text has been revised, extended and brought up to date: a new section on the transport of carbon dioxide has been added to Chapter VI and a new Chapter VIII has been introduced to cover some of the broad and comparative aspects of nutrition, digestion and metabolism; adding to the usefulness of the book.

The table of classification will be helpful to those not familiar with zoology. A very useful bibliography and a helpful subject index distinguish this volume. The get-up of the book maintains the standard expected of the well-known publishers.

M. R. R.

Propagation of Trees, Shrubs and Conifers. By Wilfred G. Sheat. (Published by Macmillan & Co., Ltd., St. Martin's St., London), 1948. Pp. 479. Price 25 *sh.* net.

This book is a comprehensive manual which treats of the various methods of propagating and multiplying the numerous classes of plant material in constant demand in nursery practice. It is not a mere discussion of theories from an academic standpoint, but is intensely practical from cover to cover. It describes in simple language and full detail the different methods of propagation in current use among nurserymen in England with reference to each of the genera and species dealt with. When more than one method is employed as in the case of certain plants, all such methods are described in the order of their popularity or success. Where different methods are applicable at different times of the year or under different seasonal conditions, these are also indicated, together with a correct appraisal of the merits and demerits, if any, of each, so that the reader who proceeds to make use of the knowledge imparted may employ in practice the method best suited to his own conditions and requirements.

Part I of the book (pp. 3-403) deals with propagation of Conifers. At the end is added a section which gives useful tables and other miscellaneous information on classification of soils, weights and measures, etc.

Angiosperms; Part II (pp. 404-448) treats of the

The range of material dealt with is limited in the main to the classes of plants cultivable out-doors in a temperate climate but includes also some of the kinds that have to be raised under glass. The propagator who wants to employ the same methods under tropical or sub-tropical conditions can profit by the information only in so far as those methods indicate the underlying principles on which the practice is based.

The author has not dwelt on the more recent methods of propagation based on the use of hormones and other chemical substances probably for the reason that some of them are regarded as being still in the experimental stage. We may well expect therefore that a book so dependably practical will soon go into a fresh edition and include a chapter on these revised practices which are fast coming into use.

B. S. Nirody.

Elsevier's Encyclopaedia of Organic Chemistry, Volume 12B. Naphthalene. Edited by F. Radt. Pages 1-344. (Published by Elsevier Publishing Co., Ltd., Distributors: Cleaver-Hume Press; Price for subscribers to whole work, £ 6-5*sh.*)

This well printed and sturdily bound documentary publication forming volume No. 12B of the set of 20 volumes of Elsevier's Encylopædia of Organic Chemistry deals with compounds containing one naphthalene nucleus. The contents of this volume have been grouped under two main sections *viz.*, (1) Hydrocarbons and (2) Halogeno-Compounds. The section on Hydrocarbons is further divided into sub-sections as (1) Naphthalene and its hydroderivatives and (2) Naphthalene and its hydroderivatives with side chains. The section on halogeno-compounds is also divided into two sub-sections as (1) halogen inside chain and (2) halogen attached to the nucleus. General literature up to and including 1944 and the literature concerning the structure up to 1948 of more than 500 naphthalenic compounds have been incorporated in this volume.

In addition to the 344 pages of chemical literature, the volume contains a 30-page des-

criptive part dealing with a general survey of the encyclopaedia, general outline and notes on its use, and containing a table of abbreviations and a table of periodicals. Further it has a 12-page subject index and a 10-page formula index. The publishers have also issued a list of 'Additions and corrections' as also a set of notes entitled 'Discrepancies in the literature' in the form of loose sheets, which is not happy as they are apt to be lost. Publication of these notes and corrections with additional literature available up to date as supplementary volume to the respective original volume, at convenient intervals, may be more useful.

The enormous accumulation of literature on the ever-increasing multitude of organic compounds has to be collected, classified and presented in a manner easily accessible to the research worker so that further advance could be made avoiding repetition and duplication. Being the first compilation of its type in the English language of the world literature on organic compounds, Elsevier's Encyclopædia should be a welcome addition to the reference library of any institution engaged in organic chemical research.

B. H. IYER.

The Report on the Socio-Economic Conditions of the Aboriginal Tribes of the Province of Madras. Edited by Dr. A. Aiyappan. (Govt. Press, Madras), 1948. Pp. 185. Price Rs. 2-2.

The Report under review is a document of considerable interest. The recommendations made for the welfare of the people may be commended on the whole. There is a laudable stress on the need of caution in changing the life of the aboriginals. For example, "podu" cultivation "should not be stopped suddenly". The Report speaks very strongly about the schools in aboriginal areas which are described as "mere apologies" for schools, very bad and dirty copies of the schools of the plains, betraying complete lack of imagination. The Report's remarks on Prohibition are sensible and moderate. It is suggested that a limited number of trees may be allowed to be tapped on condition that the toddy is to be used only for absolutely essential religious purposes. There is a wise suggestion that the simple marriage customs and freedom of women, "since their all healthy practices which civilized Indian communities are aiming at," should not be interfered with. Similarly the Report deprecates interference in the food habits of the people. There is a strong recommendation for the extension of anthropological studies which might well be followed by the Universities of Southern India.

In short, the general outlook of the Report is intelligent and humane, but the descriptive part might have been of a higher standard.

B. S. G.

Annual Report of the Director, Technological Laboratory, for the year ending 31st May 1948. Indian Central Cotton Committee, Post Box No. 1002, Bombay. Price 6 annas.

This interesting report of the activities of the Cotton Technological Research Laboratory of the Indian Central Cotton Committee, Bombay, gives a bird's-eye-view of the useful work done by the Laboratory during 1947-48 and the remarkable progress it has achieved since its inception nearly 25 years ago. The report running to 70 pages is conveniently given under various heads like Spinning, Testing House, Fibre testing, Research, Ginning, Publications, etc., facilitating ready reference. Statistical data giving details of samples received for spinning and other tests from Industrialists and Agricultural Departments all over the country reveal the increasing utility of the Laboratory and its standard technique to the country and the growing demand on its services. It would be no exaggeration to say that the steady improvement in the quality of the Indian cotton crop is as much due to the expert assistance of the Laboratory as to the patient work of the breeders. The Report gives results of tests on a number of improved strains which are quite in keeping with the spirit of the times bear attractive names like Jawahir, Subhas, Suyog, Vijay, etc. Besides these, the Laboratory maintains records of certain typical Indian cottons from all over the country grown under standard conditions year after year, which serve as a standard of reference, and cover "nearly 52% of the total area under Cotton Cultivation" (page 35).

The Testing Hourse is another useful activity of the Laboratory serving as an impartial agency to declare quality. With the introduction of labelling of textiles and standardisation of quality, which we hope the country will soon adopt, this should serve as the watch-dog of the Industry and consumers' interests.

The most important part of the Laboratory's work—Technological Research-is summarised in 17 pages (42-59) and repays careful study. A summary of several investigations on problems of ginning including the device of a new gin

and a new balance for determining ginning percentage, fibre quality in relation to mixtures, twist and yarn strength, neps and fibre quality, prediction of spinning quality from fibre particulars, cellulose sheets from linters, etc., are given. An important advancement reported is the micro-spinning technique — standard spinning process for a 60 gm. sample (as in Giza Station) and the fineness measurement by air permeability (similar to Hertel's method) which should be of considerable utility to the Industry. A summary of the paper on maturity coefficient for Indian Cottons—an improvement over Peirce and Lord's formula, is given.

The list of publications from the Laboratory as also the additional equipment purchased with details of staff, etc., are included. While it is an impressive record of the vast amount of valuable routine and research work accomplished by the Laboratory the reviewer feels that it is necessary to expand considerably its sphere of activities, so that research on industrial problems, problems of immediate and remote application in spinning, weaving, finishing, etc., are tackled by the Laboratory on the lines of the Shirley Institute instead of tabooing weaving and finishing as at present. Concentration on original research, either fundamental or applied, would perhaps in the long run be of greater benefit to the country.

If the textile industry of independent India should stand world competition, research on every aspect, from the growing of the raw material to the manufacture of the finished product and its marketing, is essential. While the Laboratory deals principally with fibres and yarn it does only a part of a job which can never be as good as doing a whole job.

The book is practically free from misprints and conforms to the usual standards of elegance of the Committee's publications; '30s' should be short for '30 counts' and as such whether '30s counts' (page 51) is correct, requires clarification.

SRINAGABHUHANA.

AQUAMETRY *

THE importance of estimation of water cannot be over emphasised both in the laboratory and in industry. The influence of moisture on chemical kinetics has been a vast subject of intensive investigation and a quick and accurate method of determination of moisture in this field of research is of paramount importance. The determination of moisture in edible and in industrial products is in no way less important. The keeping quality and the behaviour towards milling of a large number of cereals are found to be dependent on their moisture content. The breakage of the grain would enormously increase on milling if the paddy were to contain more than 13% water. The moisture content of rice should always be less than 12% for its preservation. The water content of coffee, wheat and potato chips should always be less than 12%, 9% and 7% respectively in order to ensure freedom from attack by insects and pests. Moisture plays an important role in the preservation of fruits, egg and milk powders, beverages, confectionaries, starch, oils, fats and a host of other edible products. Narrow limits of moisture content are prescribed for a large number of explosives, fuel and transformer oils, drugs and fertilizers to ensure the purity of the product and safety of preservation. The importance of a knowledge of water content in the evaluation of textiles can be visualised when it is seen that cotton and wool can take up moisture up to 25-30%. The instances mentioned above are but a few of a host of other commodities where quick and accurate method of determination of moisture is of utmost importance.

Oven drying is the oldest and perhaps the most widely employed method for the determination of moisture. Even today it is the simplest method for drying non-porous solids having no other volatile material Recently several automatic moisture recorders have been put on the market where the humidity, gas circulation and the temperature of drying can be controlled with precision. The introduction of infrared radiation as a source of heating is the latest innovation in oven drying. With this improvement, the material to be dried is uniformly heated and the temperature of dehydration is lowered. In spite of these improvements the oven method is never satisfactory either for porous solids or for substances that undergo decomposition at the temperature of heating. It is needless to say that this method cannot be employed in the case of volatile liquids.

The distillation method is usually employed in industry where a large number of samples

**Aquametry.* Application of the Karl Fischer Reagent to Quantitative Analysis involving Water. By John Mitchell (Jr.) and Donald Milton Smith, Interscience Publishers Inc. New York, 1948. Pp xi+444. Price $ 8·00.

are to be analysed for their water content. The principle in general consists in distilling the material with an organic liquid immiscible with water and measuring the volume of water in the distillate. Azeotropes are some times claimed to be more convenient. This method is specially useful in the determination of moisture of semi-wet solids like organic fertilizers, clays, vegetables, fruits etc., and can be recommended as a quick and comparative method of determining the moisture.

The absorption method is a very general and accurate one for the determination of water in a variety of complicated systems including liquids and gases. In most of the cases an inert gas is passed over the material subjected to analysis and the moisture carried over is absorbed by a suitable desiccant. Even this method suffers from the temperature defect already pointed out and porous solids take long intervals for dehydration. Most of these defects can be overcome by use of vacuum for dehydration. The quartz spring method originally developed by McBain and his associates is perhaps one of the best methods of determining moisture in solids, both porous and non-porous. Since dehydration is carried out in vacuum, the rate of dehydration is high and comparatively low temperatures can be employed. An added advantage is that the amount of dehydration for any partial pressure can be accurately determined and hence ideally suited for studies on hysterisis in sorption.

Some of the physical properties have been employed in the determination of moisture but their use is very limited. Specific gravity, viscosity and refractive index are employed in the determination of moisture in a large number of binary mixtures where water is one of the components. The determination of refractive index can also be employed for the estimation of moisture in gases. The accuracy of their method depends upon the variation of the physical properties with the moisture content of the systems and also on the absence of other impurities that may interfere with measurement of these properties.

Critical solution temperature is also employed in the determination of moisture in liquids. This method is not only troublesome to employ as an analytical routine but also suffers from want of accuracy. Heat of dilution has been employed to estimate the moisture content of the acids while infrared spectrum is used to determine the water vapour in gases particularly in gaseous hydrocarbons.

By virtue of the simplicity of manipulation the measurement of electrical conductivity, resistance or dielectric constant is coming into vogue in the routine analysis for water in some commercial products like wood, textiles, ceramics, paper, tobacco, cereals, petrolium oils etc. This method appears to be very simple but in practice it requires elaborate precautions and standardisations.

A wide variety of chemicals have been employed for the determination of water, the following being some of the reagents commonly employed to react with water, metallic sodium, calcium carbide, calcium hydride, magnesium nitride, sodamide, methyl magnesium iodide, sodium ethoxide. The gases that are produced during the reaction are estimated either volumetrically or by other analytical methods. But invariably the results obtained are mostly qualitative in nature since this involves a reaction between the solid phase and the liquid.

Smith and his collaborators developed in 1935, a new and accurate method for the determination of moisture taking advantage of the hydrolysis of acetyl chloride in presence of pyridine but soon found that substances like aldehydes, amines, lower alcohols etc., interfere in the analysis. At about the same time Karl Fischer announced that a solution of iodine, sulphur-dioxide and pyridine in methyl alcohol could be employed for the estimation of water in a large number of systems. Smith and co-workers took up this piece of investigation and carried out very valuable work elucidating the chemistry of Karl Fischer reaction. Coming as it does from pioneers in this field of research work, the book "Aquametry" gives an authoritative account of the nature and mode of application of this important reagent.

The chief difficulty that presents itself in the use of Karl Fischer reagent both to the beginner and to the experienced analyst, happens to be the instability of the reagent even under the best of experimental conditions. Even a fresh reagent has only 80% of the theoretical potency. Realising this drawback the authors have spared no pains in describing in detail, the elaborate precautions that should be taken in the preparation and application of the reagent. Whatever may be the accuracy with which moisture in methyl alcohol can be estimated, the present method is bound to fail if the moisture is not quantitatively removed by the alcohol. In a good number of insoluble systems, the authors have given numerical data regarding the accuracy of the estimation of moisture as compared with the other standard

methods. The application of Karl Fischer reagent in the estimation of moisture in a large number of organic compounds has been described in great detail. In addition to the moisture determination, the use of the reagent to estimate organic functional groups like hydroxyl, amino, carbonyl, nitrile, etc., is dealt with exhaustively. The literature on the subject is collected upto the early months of 1947 and is quite comprehensive.

In their enthusiasm to stress the importance of the reagent the authors have not been quite critical on the efficiency of the reagent when applied to certain systems. The determination of water in silica gel can be quoted as an instance. The moisture content of the gel by the Fischer reagent is 5·48% as against a value of 4·7% determined by drying the sample at 150° C. for 4 hours. It is well known that silica gel retains 4-5% water even after prolonged drying at 150° C. Hence it has to be concluded that the present method gives low values for moisture in silica gel. Similar low values are also obtained in the case of calcium sulphate. It is thus obvious that the Karl Fischer reagent cannot be employed in the case of insoluble porous solids like silica gel or alumina where the solid surface has a great avidity for water. In fact anhydrous alumina can be employed to remove the last traces of water from alcohols!

The term "Aquametry" has been coined by the authors to represent 'the analytical process of water measurement ..... of materials'. The reader would then except a detailed and critical account of the several methods that are at the disposal of the chemist for the analysis of water. But it is sad to find that the authors have devoted only 16 pages for the review of various methods in "Aquametry". Methods where physical properties like density, refractive index and viscosity are taken advantage of in the aquametry, find only a passing mention in this dook. The reader would have deen greatly benefitted if the authors had devoted about 100 pages where a critical account of the existing methods for aquametry had been given in addition to the present information about Karl Fischer reagent. The present volume can more appropriately be called by its secondary title: "Application of the Karl Fischer Reagent to quantitative Analysis involving water."

In conclusion the authors have to be congratulated for placing such a detailed and authoritative account of the Karl Fischer reagent at the hands of the analytical chemists.

M. R. A.

PEST INFESTATION RESEARCH*

THE first report of the work of the Pest Infestation Laboratory of the Department of Scientific and Industrial Research, England, has been published by the H.M.S.O. on June 7, 1949.

The laboratory was organised in response to a request from Industry for research on pest control, as related to pre-War conditions; but since the laboratory was actually constituted only after the outbreak of War, war-time problems of importance in pest control were given high priority. The most urgent of the problems, was the bulk storage of grain for long periods and in environments which proved propitious for insect development. While the Ministry of Food's Infestation Control Division did the work of inspection of stored food and the application of appropriate control methods, the Pest Infestation Laboratory's task was to undertake research to enable the Control Division to operate efficiently. This meant getting to know all about the insects in relation to their food-stuff and the conditions under which it was stored. The work, therefore, involved biological studies of the insects and the mites and physical studies of the environment of the grain in bulk and in storage.

Three main lines of work that engaged the attention of the Pest Infestation Laboratory were— (1) Estimation of Infestation; (2) Development of control measures; and (3) Research on sprays. The estimation of the infestation of a given sample of grain was made possible by the improvisation of the "Carbon dioxide method", through which the "Carbon dioxide figure" for that sample could be worked out. Both the grain and insects infesting it produce together measurable quantities of carbon dioxide. Broadly the concentration of carbon dioxide found in the mass of grain stored is proportional to the number of insects present inside the grain. A related finding in this connection was that insects could and did cause grain to "heat" through the formation of "hot spots". Of the control methods developed, the fumigation of silo bins was the most important and is being used now on a very large scale. Re-

* Department of Scientific and Industrial Research, Rex-House, 4-12 Regent Street, London.

lating closely to fumigation of grain, were problems like the penetration of the gas into the food-stuff, its physical adsorption or chemical reaction and the nature and permanence of residual effects, in addition to the toxicity of the gas to the many insect species concerned. Sprays for the disinfestation of warehouses in which insect-free food-stuffs had to be stored, were developed. In order to ensure a reasonably long toxic life of the insecticide film deposited on walls, boxes, etc., a method was developed for pretreating the surfaces to be sprayed, which gave a greatly increased duration of toxicity.

The Pest Infestation Laboratory also undertook work on fly-sparys on behalf of the fighting services and was among the first to report on the striking toxicity of DDT to house-flies. A new spray-gun was also developed designed to withstand the toughest treatment and at the same time to provide an accuracy of performance not hitherto achieved.

In this context, the present conditions obtaining in India are of special interest. A somewhat parallel organisation to the Ministry of Food's Infestation Control Division in England, was set up in India practically after the cessation of the Second Great War, under the title—"Directorate Storage", whose duty was was laid down to be the dissemination of knowledge in respect of useful methods of large-scale storage of locally-procured and imported grains of different kinds and the training of personnel for organising proper storage and promoting "go-down hygiene" and issuing of useful propaganda leaflets prescribing certain definite regulation to be followed. But no research laboratory of the kind of the Pest Infestation Laboratory in England, was set up, to undertake research to enable the control personnel to operate efficiently. Problems like the fumigation of silo bins in England, are numerous in India and have long been waiting to be tackled with special reference to the peculiar and varying Indian conditions of storage of grains. Estimation of infestation of grain under Indian methods of storage and in a variety of receptacles used for storage, is vastly different from that applying to the silo bins. Equally different are the problems like the penetration of the gas, its sorption and the nature and permanence of residues, etc., in India. A host of other allied matters have been in need of investigation. A special well equipped central laboratory with competent staff alone could undertake research on these important and urgent problems.

The Indian Agricultural Research Institute at Delhi and the Agricultural laboratories in the several Provinces and States have never been properly and adequately staffed and financed for the purpose of conducting research on the varied problems; and the results already obtained by workers in these laboratories and by workers of special schemes financed by the Indian Council of Agricultural Research have not covered a wide enough field. One of the chief reasons for this state of affairs is the inherent defect in the organisation and working and lack of co-ordination. These could perhaps be remedied by organising a central Pest Infestation Research Laboratory, generously equipped and adequately staffed, and Bangalore would appear to offer an ideal place for locating the laboratory not only because of the substantial amount of pioneering work which has been carried out by the Entomological section of the Department of Agriculture but also on account of an active school of research on Insect Nutrition and Insect Physiology which has developed in the Division of Fermentation Technology at the Indian Institute of Science.

BEE COMPASS

Sunlight and the polarized light of the sky appear to enable a scout bee which has discovered a source of nectar to orient herself when executing a bee dance to tell other bees about her find. Distance is indicated by the dance pattern, direction by the way the bee's body is pointed most of the time, according to the Austrian entomologist, Professor Karl von Frisch. *Science Service* reports his announcement of this discovery at a recent meeting of scientists in Washington D. C.

In total darkness or red light (which bees cannot perceive) the finder-bee became confused in her dance, but oriented herself toward the nectar find when a flashlight was held in the approximate position of the sun. When the flash-light "sun" was held in a false position, the bee gave an incorrect direction. The bee was also properly oriented when she could see a small patch of blue sky (polarized light) but became confused in the unpolarized light of a white cloud drifting across the opening. (By courtesy to *Sky and Telescope*, 1949, VIII, P. 253.)

SCIENCE NOTES AND NEWS

V-2 Solar Spectra

The ultraviolet spectra of the sun obtained during the V-2 flights of October 10, 1946 (*Sky and Telescope*, February 1947, p. 3), and March 7, 1947, have now been measured. In a report by E. Durand, J. J. Oberly, and R. Tousey, released by the Naval Research Laboratory, some 200 atomic lines between wave lengths 2200 and 3000 angstroms have been identified as arising from 10 elements, either in the neutral (I) or the singly ionized (II) state. These are iron I and II, chromium I and II, vanadium I and II, manganese II, magnesium I and II, calcium I, nickel I, titanium I, cobalt I and II, and silicon I. In these identifications the authors made extensive use of laboratory results and theoretical multiple tables by Dr. Charlotte Moore Sitterly, of the National Bureau of Standards.

Special attention is drawn to strong emissions of ionized magnesium at wave lengths 2803 and 2796 that had been predicted by Dr. Donald H. Menzel, of Harvard. In the previously observable spectra of the solar disk only the H and K lines of ionized calcium had shown emission, and they are weak in comparison with the newly observed ionized magnesium pair.

Noted incidentally was a strong band of nitric oxide at wave length 2264, presumably arising in our atmosphere. This spectrum had been obtained at an altitude of 55 kilometers. An average concentration of 0·01 per cent. of nitric oxide in the outer atmosphere would be detectable.

The complete report on the identification of the lines in the solar spectra obtained from V-2 flights will appear shortly in the *Astrophysical Journal* (By Courtesy to *Sky and Telescope*, 1949, Vol. VIII, P. 89.)

Central Institute Potato for Research

The Central Potato Research Institute set up a few months back by the Ministry of Agriculture, Government of India, started functioning at Patna, its permanent location, about a fortnight ago. The Institute which is believed to be the first of its kind in the East, will coordinate research so far undertaken in various sub-stations of the Indian Council of Agricultural Research at Simla, Bhowali and Kufri and will chalk out a scheme for fundamental research on the production and utilization of the potato crop.

For the present, the Institute has started functioning in premises borrowed from the Government of Bihar who have placed a 25 acre plot and a few rooms, for laboratory and office purposes, at its disposal. Permanent buildings are not proposed to be built now in view of the need for economy in Government expenditure. When the financial situation eases, construction of permanent buildings will be taken up.

In India, although the soil is suitable in most areas for potato cultivation, only about 0·2 per cent of the total crop area is under potato and the annual production is about 1,800,000 tons. Leaving aside the quantity required for seed purposes, about 8 lbs. of potato are available annually per head as against about 500 lbs. per head per annum in some of the Western countries.

The main obstacles in the way of increased production of potato in India are: 1) absence of different varieties of potato suited to varying conditions of climate and soil in different parts of the country; 2) non-availability of sound, healthy seed in adequate quantities, at the right time and at a reasonable price and 3) the heavy toll taken by fungal, bacterial and virus diseases and insect pests. The Institute will undertake research into these problems.

Indian Medicinal Plants

A scientific enquiry, extending over a period of 12 years, on Indian medicinal plants and food poisons which was launched under the auspices of the Indian Council of Agricultural Research in 1935 has now been completed and Col. R. N. Chopra, at present Director, Drugs Research Laboratory, Srinagar, who conducted the enquiry, has submitted his final report to the Council.

Publications of a monograph on poisonous plants in India, establishment of a Herbarium of medicinal and poisonous plants, preparation of a list of Indian Pharmacopœ and encouragement to the cultivation of medicinal plants in the country are some of the tangible achievements arising out of the scheme. Besides, the results of the enquiry have also been of considerable assistance to the establishment of the Central Drug Research Laboratory at Lucknow.

The Report says that the enquiry has definitely advanced the knowledge with regard to pharmacopœial and allied drugs in India. A number of firms manufacturing drugs from Indian medicinal plants have come into existence and, instead of depending on concentrated

extracts from foreign countries, practically every type of galenical is now being manufactured in India from materials produced in the country.

India is the emporium of all kinds of medicinal herbs and drugs and, with suitable facilities, she can produce not only enough for her internal requirements but can also spare considerable quantities for export. The enquiry has stimulated cultivation of medicinal plants. Among drugs which have been brought into extensive cultivation may be mentioned belladonna, digitalis, hyoscyamus, colchicum, gentian, ephedra, pyrethrum, etc., etc.

Indian Central Cotton Committee

The Government of India have appointed the following as members of the Indian Central Cotton Committee, representing the various interests concerned:

Shri R. G. Saraiya (Co-operative Banking), Shri Madanmohan Mangaldas (Ahmedabad Millowners' Association), Shri G. M. Kothari, M. L. A. (Cotton Ginning or Manufacturing Industry in Madras), Shri A. K. D. Balarama Raja (Cotton Growing Industry in Madras), Shri Narayan Dass Mukerjee, Director of Food and Civil Supplies, Vindhya Pardesh, and Seth Bhogilal M. Shah (United State of Kathiawar).

The following have been appointed as Additional Members:—

Shri Neville Wadia, Pandit Thakar Dass Bhargava, Member, Constituent Assembly of India, Shri Bhawanji A. Khimji, President, Indian Merchants' Chamber, Bombay, and Shri T. P. Barat, Textile Commissioner to the Government of India.

Post-Graduate Research Grants for Indians

Two Indians are among the 32 Commonwealth university teachers and post-graduate research workers to whom travel grants under a new scheme have been awarded by the British Council for the purpose of study at British universities.

The Indian beneficiaries are Mr. O. P. Bhatnagar of Allahabad University, who is now studying history at the University of London, and Mr. B. Bhattacharya from Benares University who will shortly be reaching Cambridge to study spectroscopy.

The scheme, established as a result of the discussions at the first post-war Congress of Universities of the Commonwealth held last year at Oxford, is intended to facilitate the interchange of university teachers and scholars between the Commonwealth countries and the United Kingdom.

Facilities for Displaced Students

The University of Saugor and the Birla Education Trust, Pilani, have offered to take refugee students who may be unable to continue their college studies in Delhi for want of accommodation in local colleges. Students desirous of availing this opportunity may contact the Registrar, University of Saugor, Saugor C. P. or Principal, Birla College of Arts, Science and Commerce, Pilani, Jaipur Division, Rajasthan for terms and conditions of admission.

Mathematical Society

The Sixteenth Conference of the Indian Mathematical Society will be held in Madras under the auspices of the University of Madras on the 26th, 27th and 28th December, 1949.

Prof. M. H. Stone of Princeton, Dr. Tietjens of the Indian Instiute of Science, Prof. Hermann Wold of Sweden are enpected to attend the session. A Mathematical Exhibition will be held during the period.

The Geological, Mining & Metallurgical Society of India

The Geological, Mining and Metallurgical Society of India held its 25th Annual General Meeting on Friday, the 16th September 1949, in the Rotary Hall of the Great Eastern Hotel, Calcutta. Dr. M. S. Krishnan presided and Dr. D. N. Banerjee, the Vice-Chancellor of the Calcutta University, was the Chief Guest on this occasion.

Andhra University—Award of Research Degree in Chemistry

On the recommendation of the Board of Examiners consisting of:—

1. Dr. N. H. Burman (*Chairman*), Professor of Chemistry, Frick Chemical Laboratory, Princeton University, Princeton, New Jersey, U.S.A, 2. Dr. James J. Lingane, Harvard University Department of Chemistry, 12, Oxford Street, Cambridge 38, Massachusetts, U. S. A., 3. Professor G. Fredrick Smith, Associate Professor, University of Illinois, Illinois, U. S. A. appointed to adjudicate on the thesis entitled "Catalyzed and Induced Reactions in Analytical Chemistry". the Syndicate has resolved that Mr. J. V. S. Ramanjaneyulu, M. Sc., be declared qualified for the Degree of Doctor of Science (D.Sc.)

ERRATUM

Vol. XVIII, No. 7, July 1949, page 232

Article on "The Theory of the Christiansen Experiment"—In Column 2, the correct formula should read as follows:

$$I = I_0 \cdot e^{-\pi^2(\mu_1-\mu_2)^2 \Delta z/\lambda^2}$$

Editor: M. Sreenivasaya, B.A., F.I.I.Sc., F.A.Sc.
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